IDAHO Department of Water Resources

ESPA Water Level Changes and Estimated Volume of Water

Mike McVay

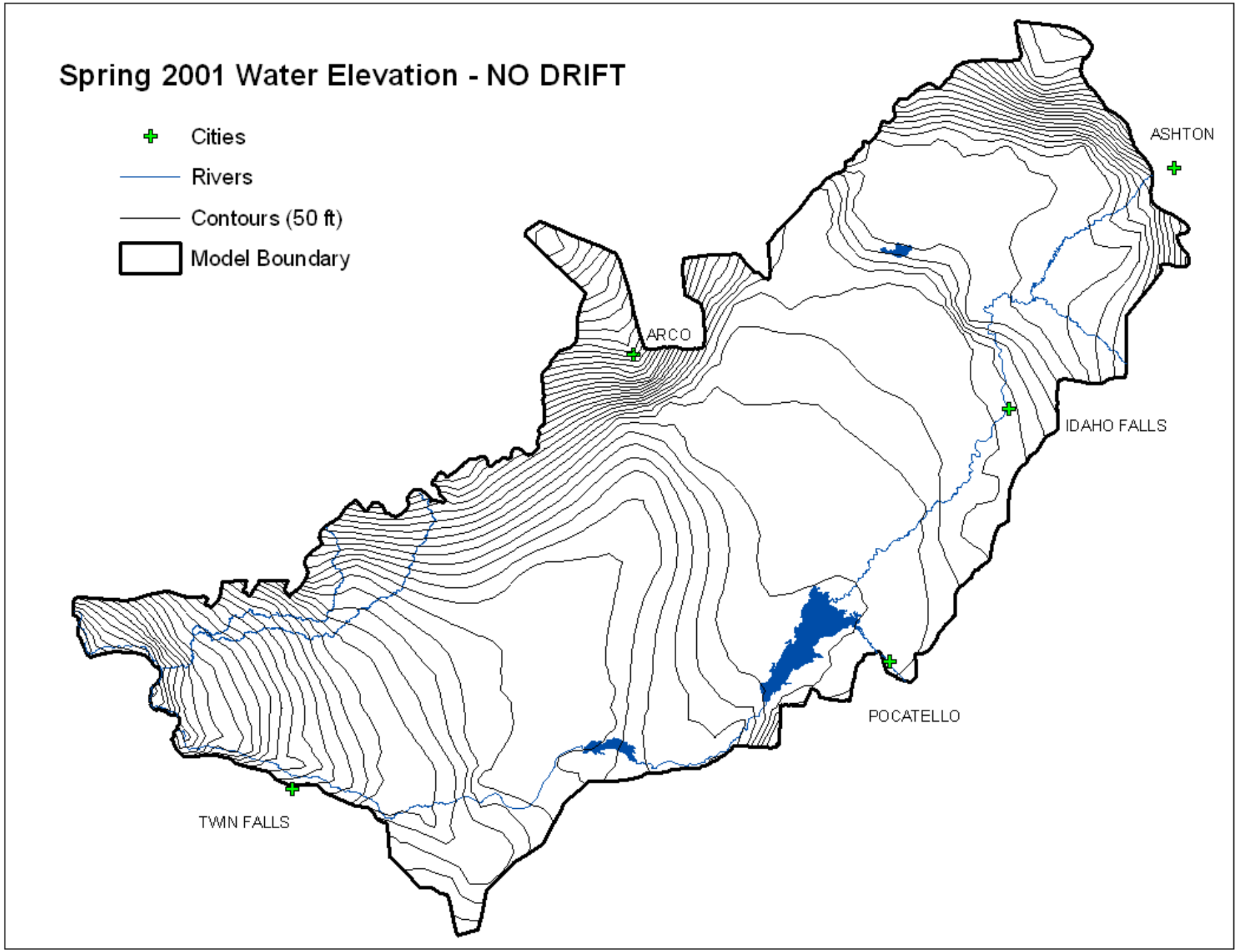
11/22/2010

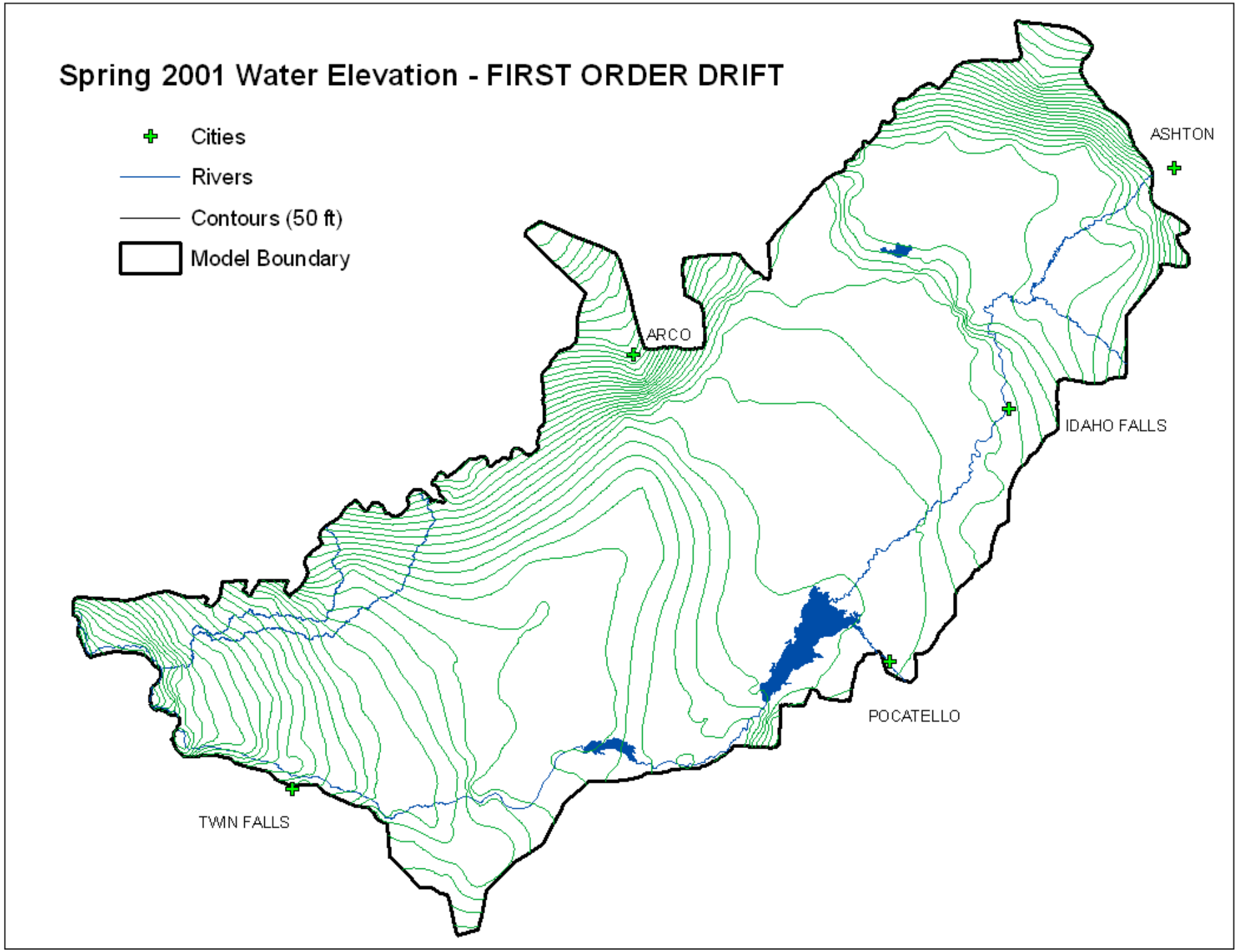
Questions from last meeting

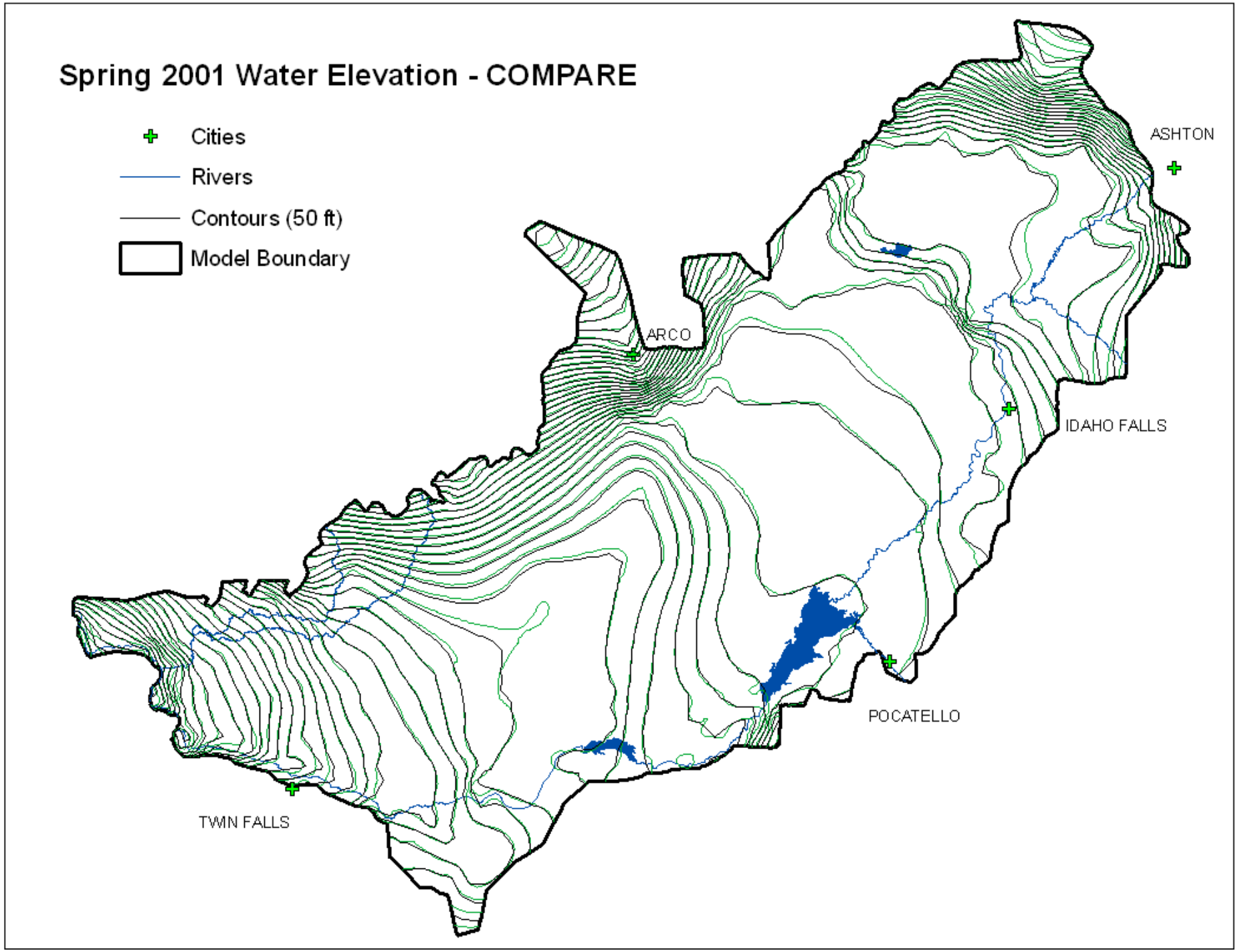
- What will a linear drift do to water-level contours in the northeast?
- Is the positive water-level change near Wendell representative?
- Do Oakley area wells represent the regional aquifer?

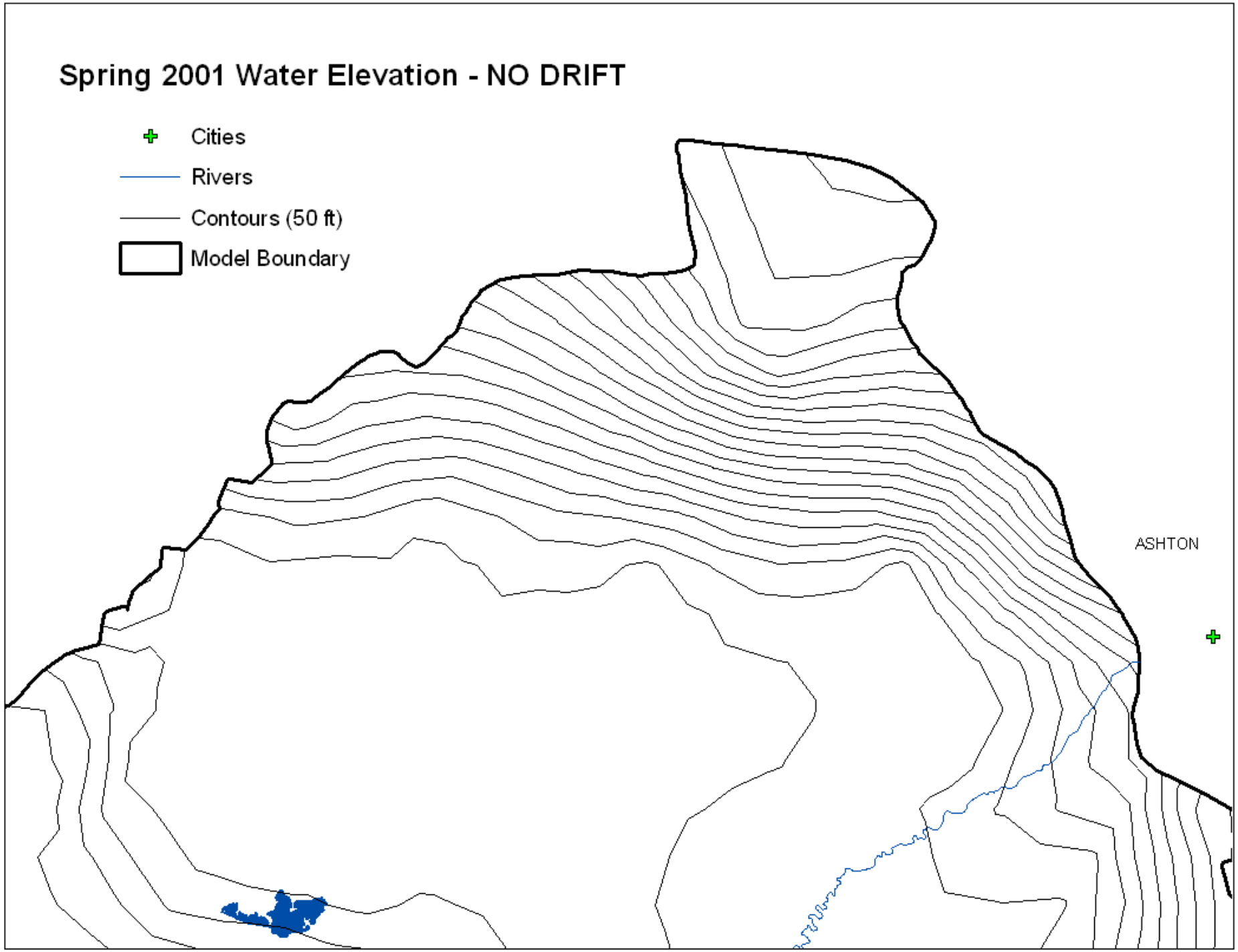
Linear Drift

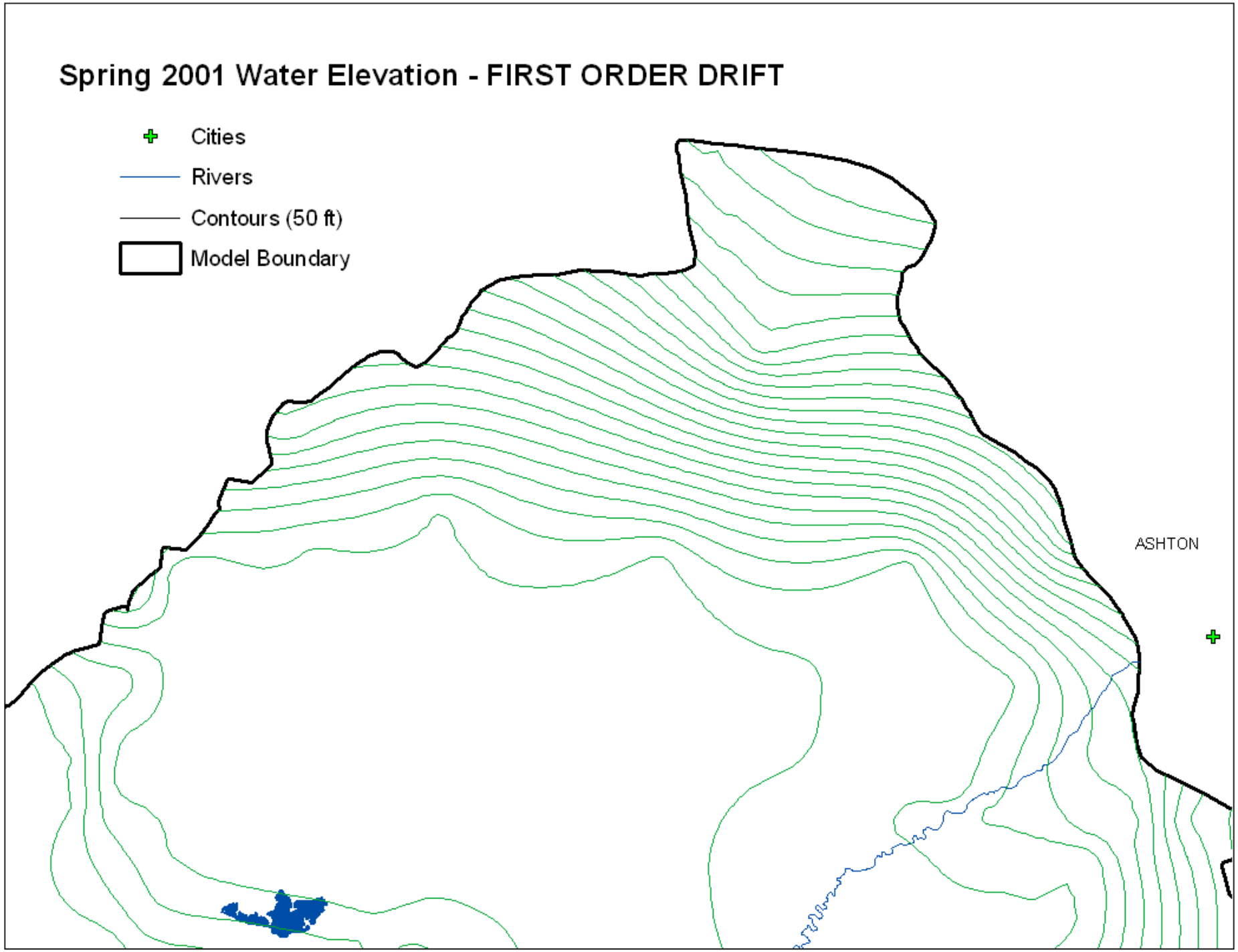
- Previously used Ordinary Kriging which assumes no trend in the data
- Universal Kriging with linear drift (First Order Trend Removal).

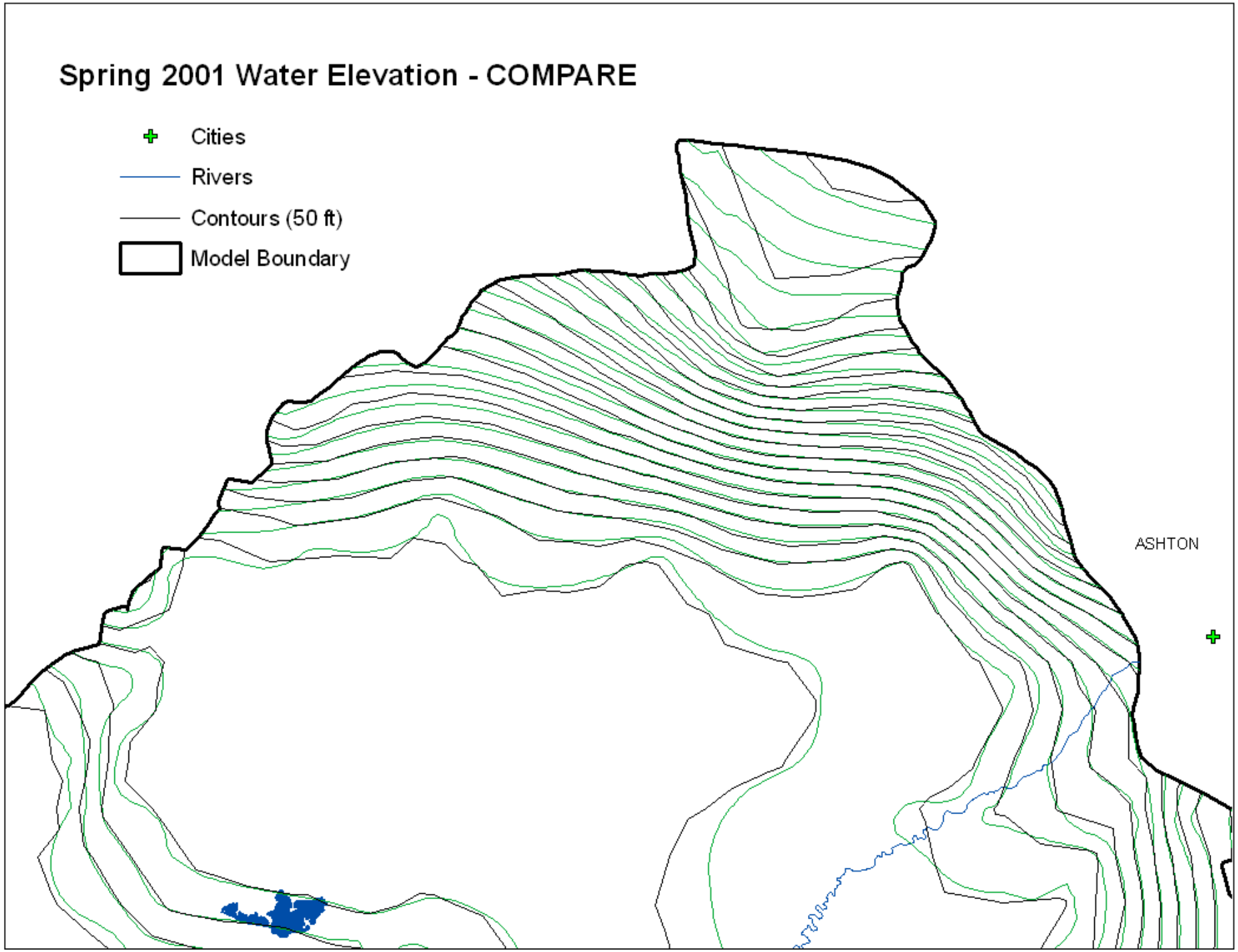

Spring 2001 Water Elevation - NO DRIFT
Cities
Rivers
Contours (50 ft)
Model Boundary
ASHTON
ARCO
IDAHO FALLS
POCATELLO
TWIN FALLS

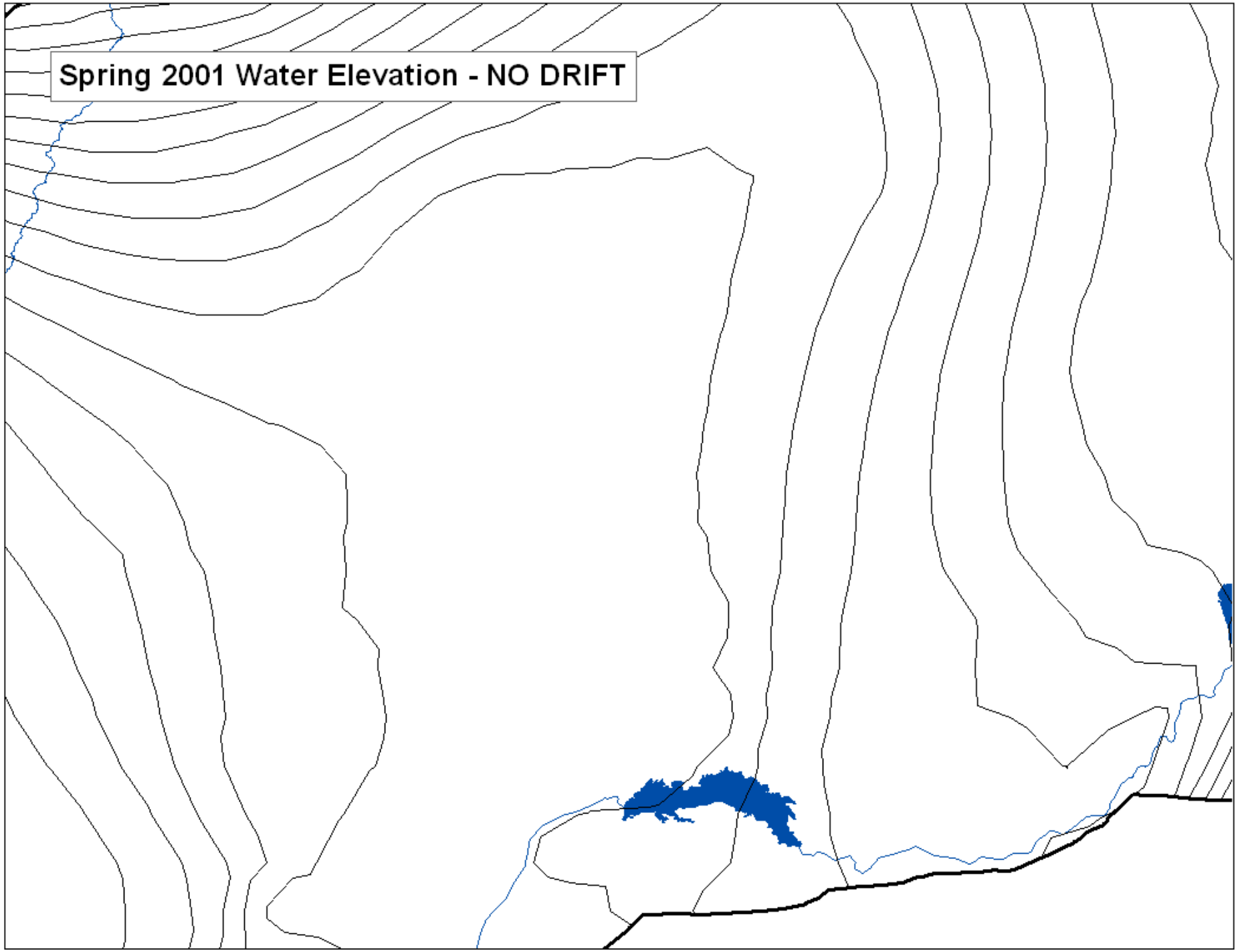

Spring 2001 Water Elevation - FIRST ORDER DRIFT
Cities
Rivers
Contours (50 ft)
Model Boundary
ASHTON
ARCO
IDAHO FALLS
POCATELLO
TWIN FALLS

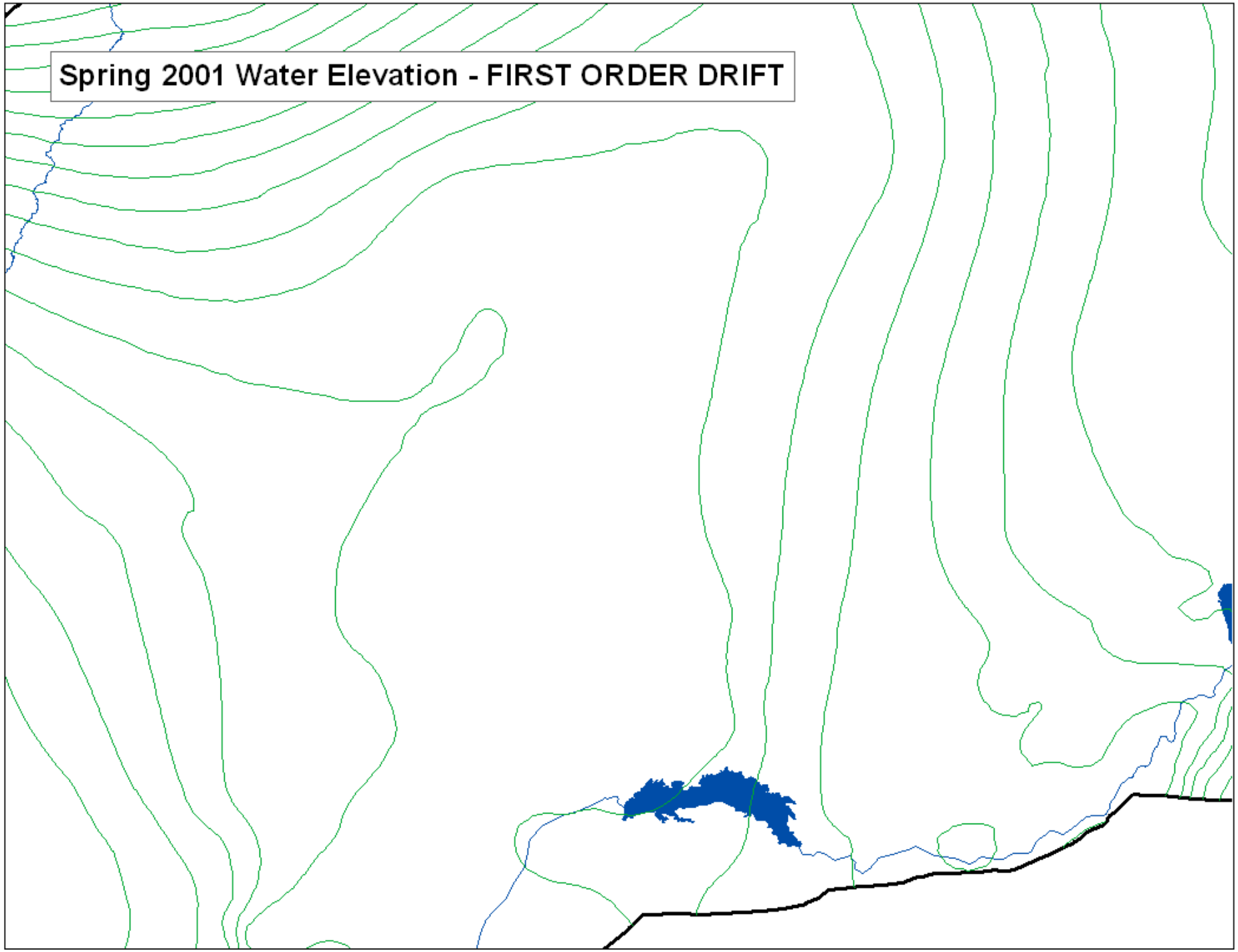

Spring 2001 Water Elevation - COMPARE
Cities
Rivers
Contours (50 ft)
Model Boundary
ASHTON
ARCO
IDAHO FALLS
POCATELLO
TWIN FALLS

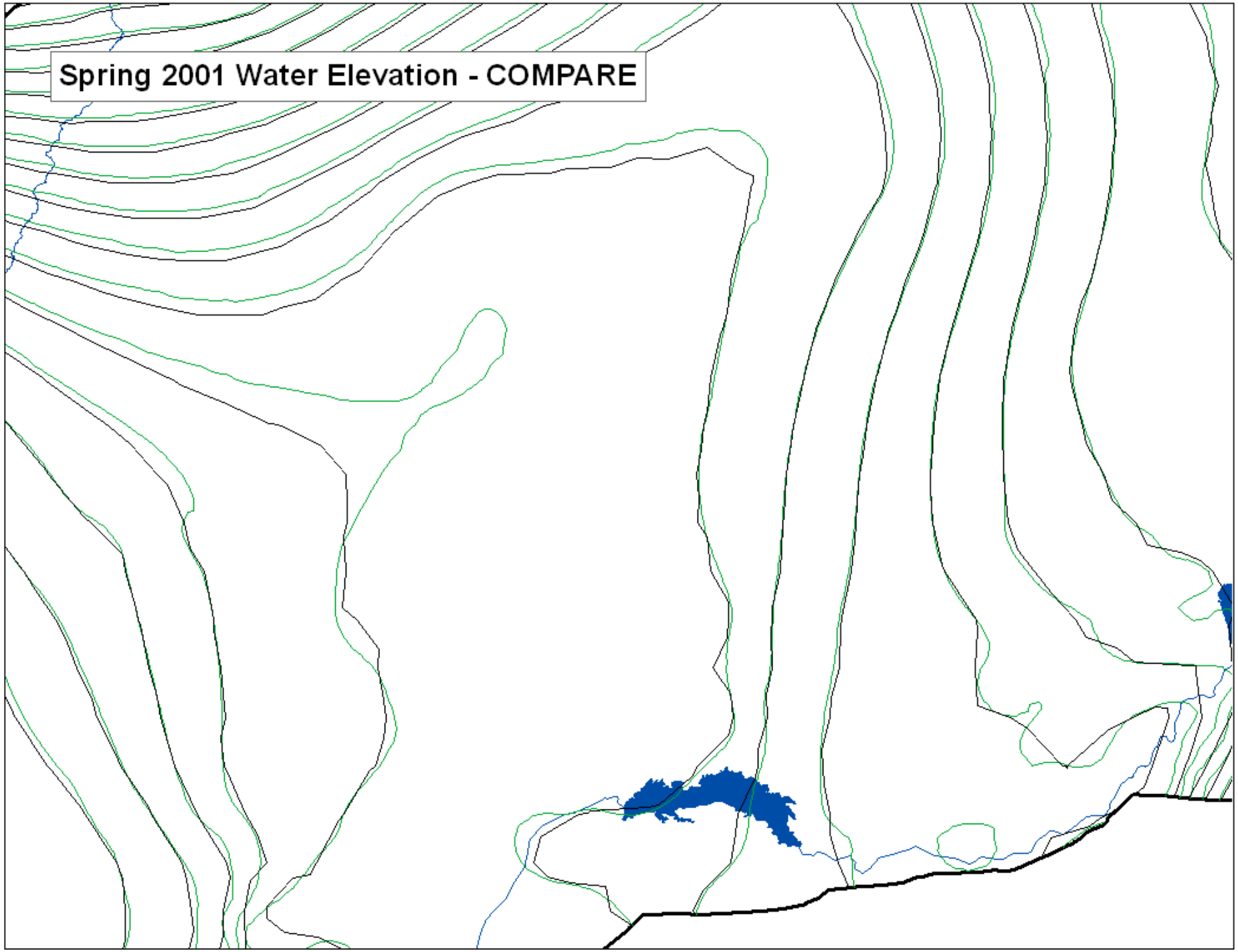

Spring 2001 Water Elevation - NO DRIFT
Cities
Rivers
Contours (50 ft)
Model Boundary
ASHTON


Spring 2001 Water Elevation - FIRST ORDER DRIFT
Cities
Rivers
Contours (50 ft)
Model Boundary
ASHTON


Spring 2001 Water Elevation - COMPARE
Cities
Rivers
Contours (50 ft)
Model Boundary
ASHTON


Spring 2001 Water Elevation - NO DRIFT

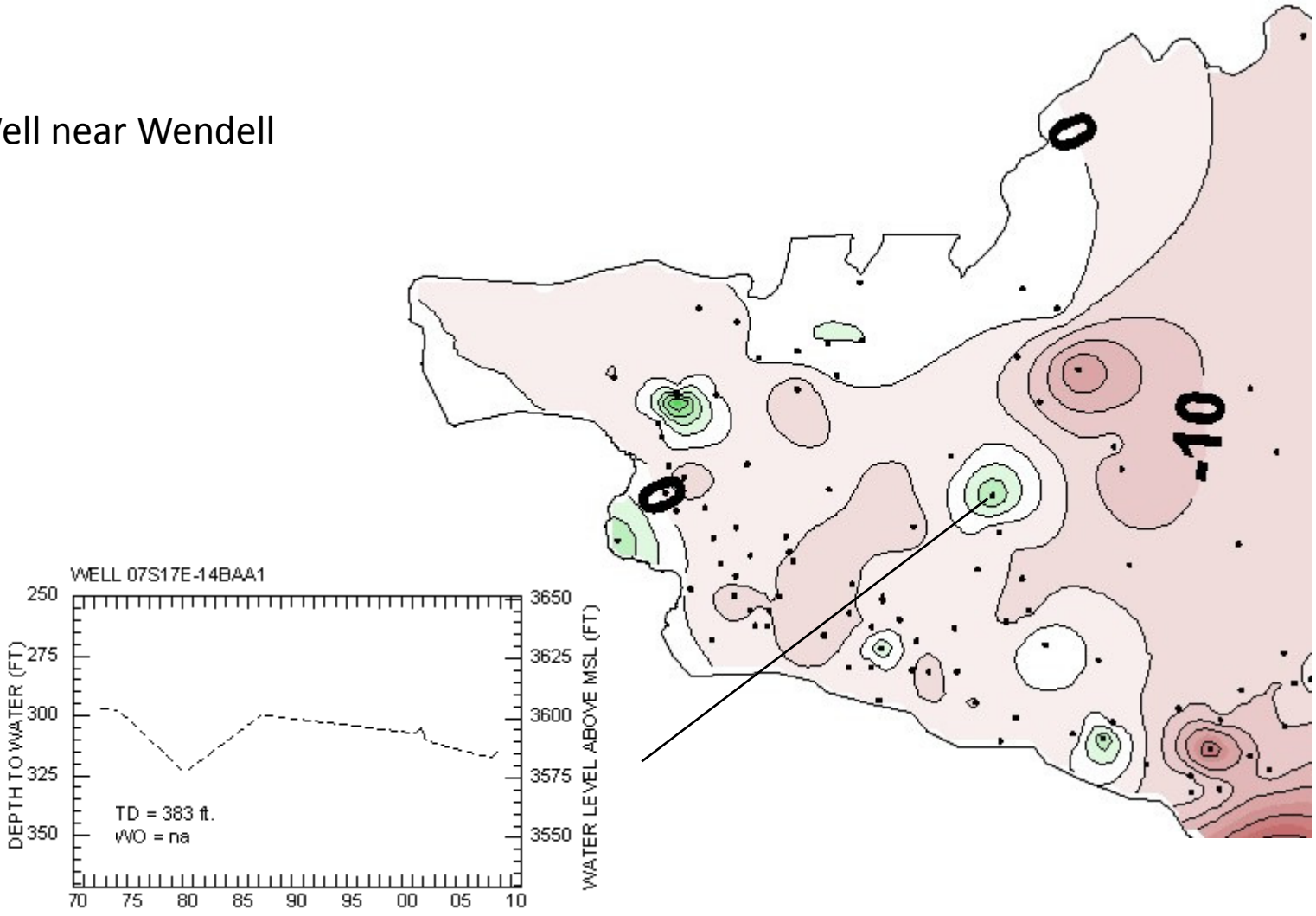

Spring 2001 Water Elevation - FIRST ORDER DRIFT


Spring 2001 Water Elevation - COMPARE

Wendell and Oakley area wells

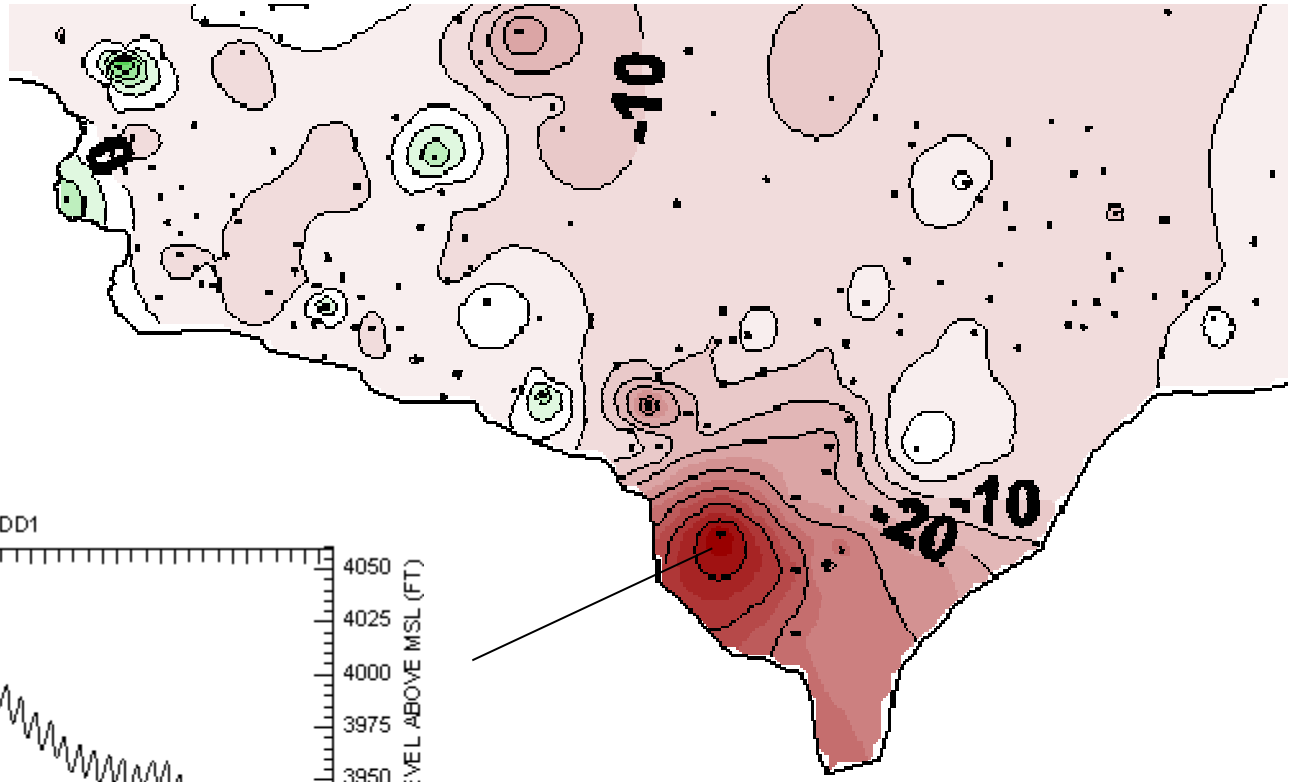
- Well near Wendell showed positive water-level changes while surrounding area showed declines.
- Appeared that two wells were “driving” the large water-level declines in the Oakley area.

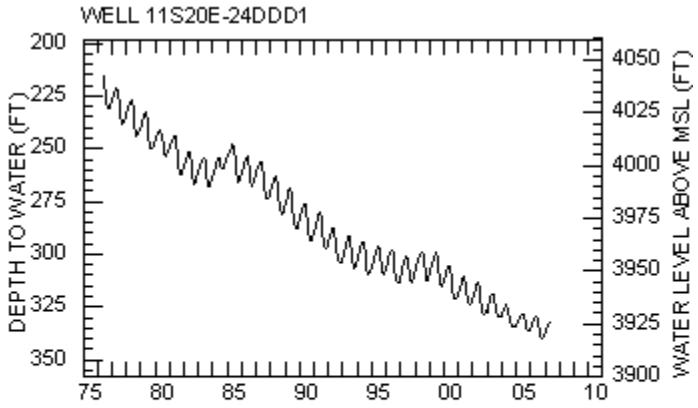
Well near Wendell



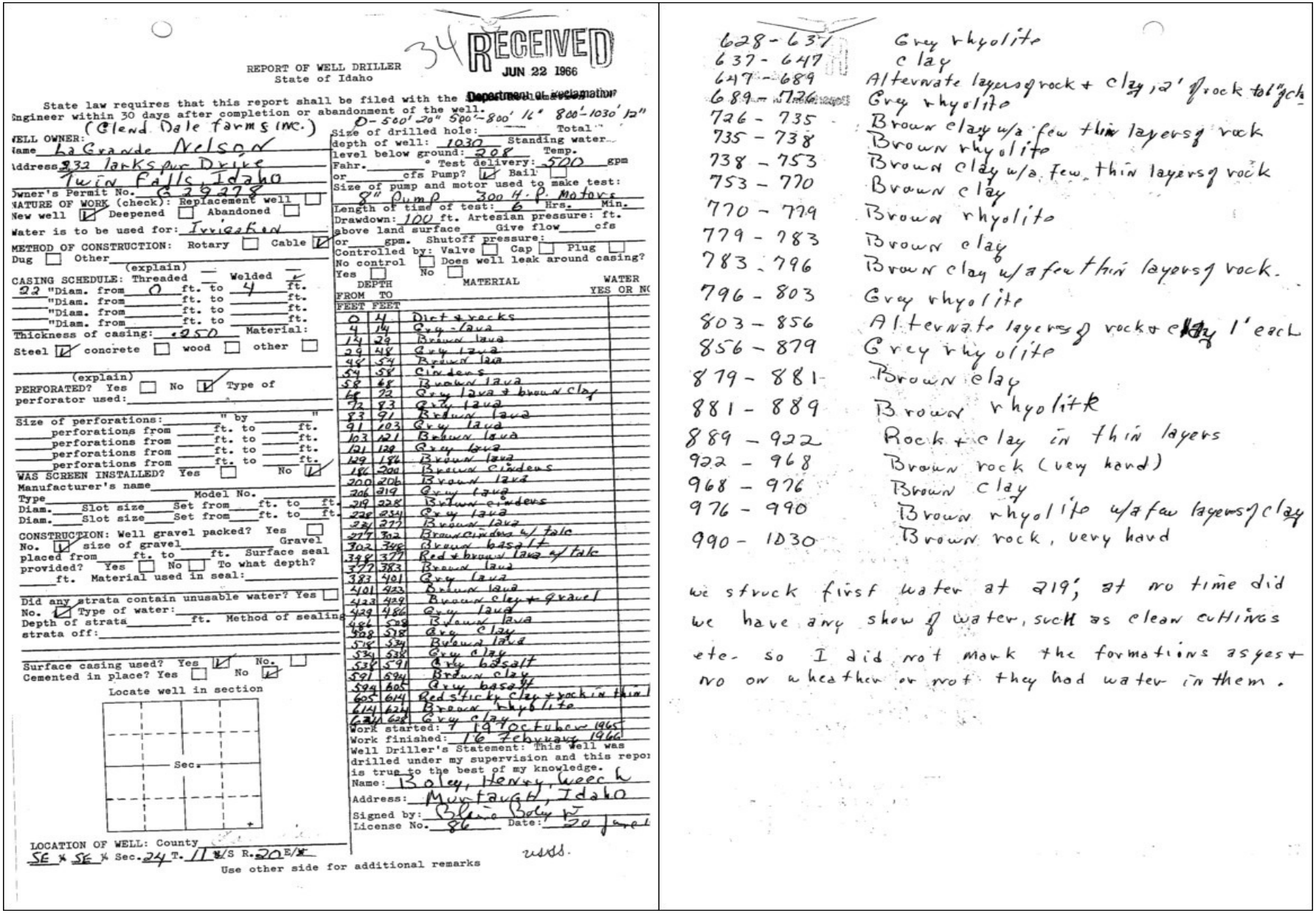
Very little information is available for well 07S17E-14BAA1. The well is 383’ deep and completed in Snake River Group basalt. Although the well driller’s log could not be located, it was observed that several injection wells are located nearby.

Well 11S20E-24DDD1 in Oakley fan area





TD = 1030 ft.
WO = 4-1030 ft.



REPORT OF WELL DRILLER
State of Idaho

34 RECEIVED
JUN 22 1966

State law requires that this report shall be filed with the Department of Reclamation
Engineer within 30 days after completion or abandonment of the well.

(Glend Dale Farms Inc.)

WELL OWNER:
Name La Grande Nelson
Address 232 Larkspur Drive
Twin Falls, Idaho
Owner's Permit No. G29278
NATURE OF WORK (check): Replacement well ☐
New well ☑ Deepened ☐ Abandoned ☐
Water is to be used for: Irrigation
METHOD OF CONSTRUCTION: Rotary ☐ Cable ☑
Dug ☐ Other ☐
(explain)
CASING SCHEDULE: Threaded ☐ Welded ☑
22 "Diam. from 0 ft. to 4 ft.
"Diam. from ft. to ft.
"Diam. from ft. to ft.
"Diam. from ft. to ft.
Thickness of casing: .250 Material:
Steel ☑ concrete ☐ wood ☐ other ☐
(explain)
PERFORATED? Yes ☐ No ☑ Type of perforator used:
Size of perforations: " by "
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
WAS SCREEN INSTALLED? Yes ☐ No ☑
Manufacturer's name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.
CONSTRUCTION: Well gravel packed? Yes ☐
No. ☑ size of gravel Gravel placed from ft. to ft. Surface seal provided? Yes ☐ No ☐ To what depth? ft. Material used in seal:
Did any strata contain unusable water? Yes ☐
No. ☑ Type of water:
Depth of strata ft. Method of sealing strata off:
Surface casing used? Yes ☑ No. ☐
Cemented in place? Yes ☐ No ☑

Locate well in section

LOCATION OF WELL: County
SE ¼ SE ¼ Sec. 24 T. 11 ☑/S R. 20 E/☑
Use other side for additional remarks

Size of drilled hole: 0-500' 20" 500'-800' 16" 800'-1030' 12" Total
Depth of well: 1030 Standing water level below ground: 208 Temp. Fahr. ° Test delivery: 500 gpm or cfs Pump? ☑ Bail ☐
Size of pump and motor used to make test: 8" Pump 300 H.P. Motors
Length of time of test: 6 Hrs. Min.
Drawdown: 100 ft. Artesian pressure: ft. above land surface Give flow cfs or gpm. Shutoff pressure:
Controlled by: Valve ☐ Cap ☐ Plug ☐
No control ☐ Does well leak around casing? Yes ☐ No ☐

DEPTH FEET FROM	DEPTH FEET TO	MATERIAL	WATER YES OR NO
0	4	Dirt & rocks	
4	14	Grey lava	
14	24	Brown lava	
24	48	Grey lava	
48	54	Brown lava	
54	58	Cinders	
58	68	Brown lava	
68	72	Grey lava & brown clay	
72	83	Grey lava	
83	91	Brown lava	
91	103	Grey lava	
103	121	Brown lava	
121	128	Grey lava	
129	186	Brown lava	
186	200	Brown cinders	
200	206	Brown lava	
206	219	Grey lava	
219	228	Brown cinders	
228	234	Grey lava	
234	277	Brown lava	
277	302	Brown cinders w/ talc	
302	348	Brown basalt	
348	377	Red & brown lava w/ talc	
377	383	Brown lava	
383	401	Grey lava	
401	423	Brown lava	
423	429	Brown clay & gravel	
429	486	Grey lava	
486	508	Brown lava	
508	518	Grey clay	
518	534	Brown lava	
534	538	Grey clay	
538	591	Grey basalt	
591	594	Brown clay	
594	605	Grey basalt	
605	614	Red sticky clay & rock in thin	
614	624	Brown rhyolite	
624	628	Grey clay	

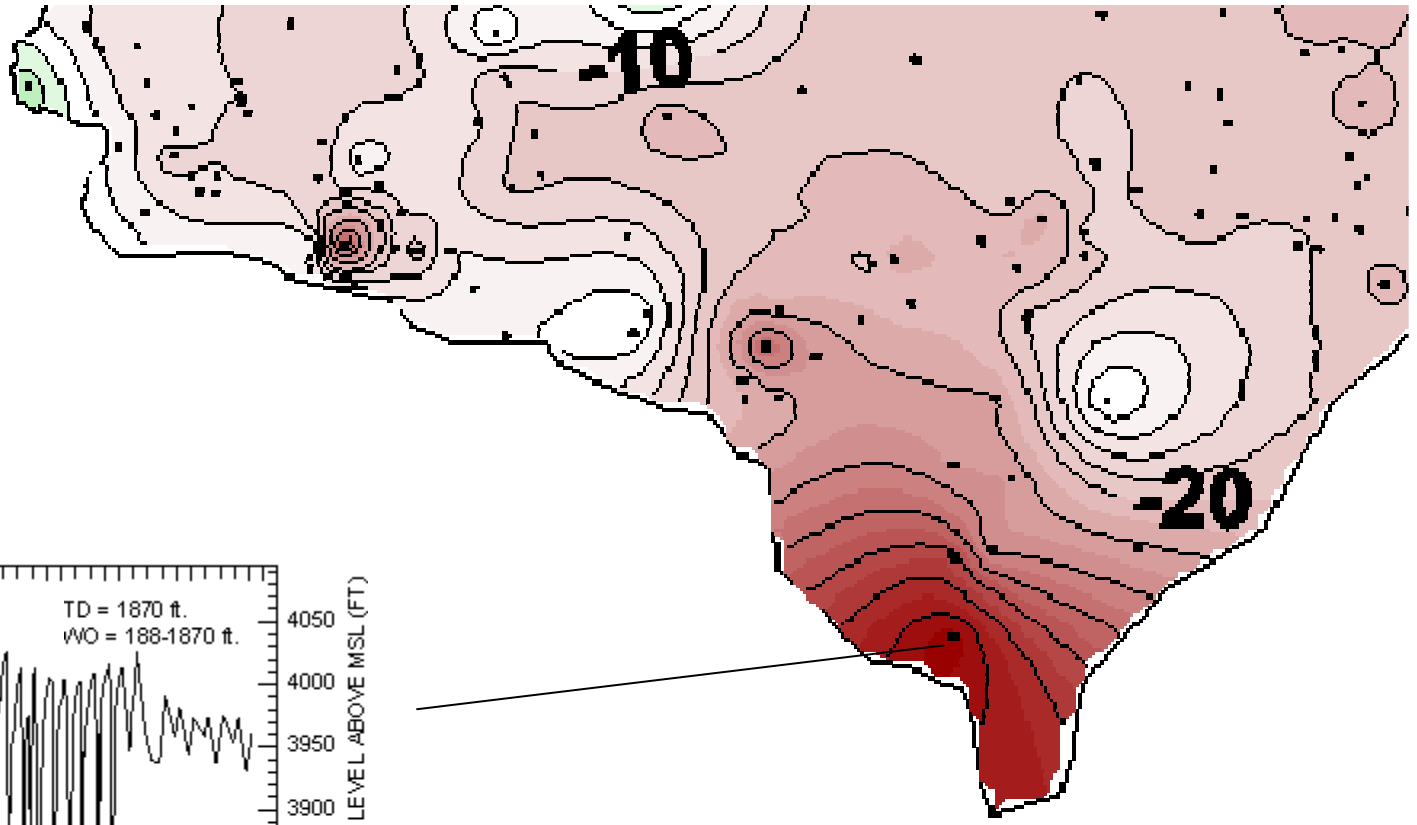
Work started: 7 19 October 1965
Work finished: 16 February 1966
Well Driller's Statement: This well was drilled under my supervision and this report is true to the best of my knowledge.
Name: Boley, Henry, Weech & Boley
Address: Murtaugh, Idaho
Signed by: Blaine Boley
License No. 86 Date: 20 June
USGS.

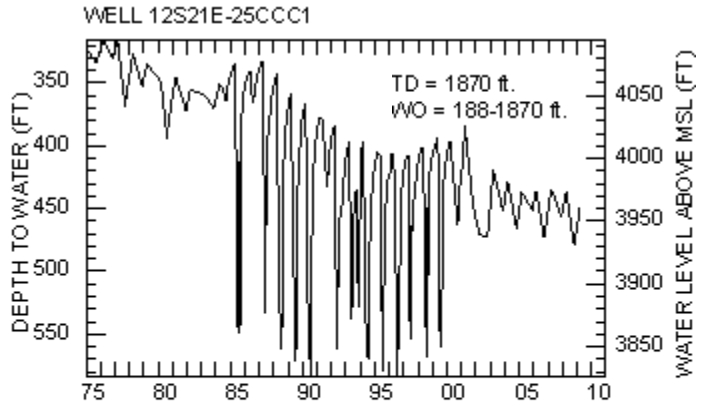
628 - 637	Grey rhyolite
637 - 647	clay
647 - 689	Alternate layers of rock + clay, 2' of rock to 6" of clay
689 - 726	Grey rhyolite
726 - 735	Brown clay w/a few thin layers of rock
735 - 738	Brown rhyolite
738 - 753	Brown clay w/a few thin layers of rock
753 - 770	Brown clay
770 - 779	Brown rhyolite
779 - 783	Brown clay
783 - 796	Brown clay w/a few thin layers of rock.
796 - 803	Grey rhyolite
803 - 856	Alternate layers of rock & clay 1' each
856 - 879	Grey rhyolite
879 - 881	Brown clay
881 - 889	Brown rhyolite
889 - 922	Rock & clay in thin layers
922 - 968	Brown rock (very hard)
968 - 976	Brown clay
976 - 990	Brown rhyolite w/a few layers of clay
990 - 1030	Brown rock, very hard

we struck first water at 219'; at no time did we have any show of water, such as clean cuttings etc. so I did not mark the formations as yes + no on whether or not they had water in them.

Well 11S20E-24DDD1 completed as open hole through basalt into rhyolite. First water at 219', but not enough water from any depth to report in log.

Well 12S21E-24CCC1 in Oakley fan area





Well Log Form 1
4/59 1 M

047722

SHEET NO. 1

WELL LOG

From Feet	To Feet	Type of Material	Water-bearing Formation Ans. Yes or No	Casing Perforated Ans. Yes or No
0	5	Topsoil & hardpan		
5	25	Gravel & clay		
25	45	Clay & sand		
45	50	Cemented gravel, solid		
50	160	Yellow clay & gravel		
160	186	Sandy clay & gravel		
186	211	Dark gray lava, solid		
211	219	Brown & red clay		
219	234	Brown lava, solid		
234	320	Light gray lava, hard		
320	332	Red lava		
332	357	Red lava cinders & clay		
357	513	Brown rhylite, broken		
513	520	Black lava, solid		
520	587	Brown rhylite, broken		
587	597	Black rhylite, hard		
597	610	Brown clay		
		If more space is required use Sheet No. 2		

WELL DRILLER'S STATEMENT

This well was drilled under my supervision and the above information is complete, true and correct to the best of my knowledge and belief.

Signed_____

By_____

License No._____

Dated_____, 19____

SHEET NO. 2

Well Owner Grigg, Anderson, Granne

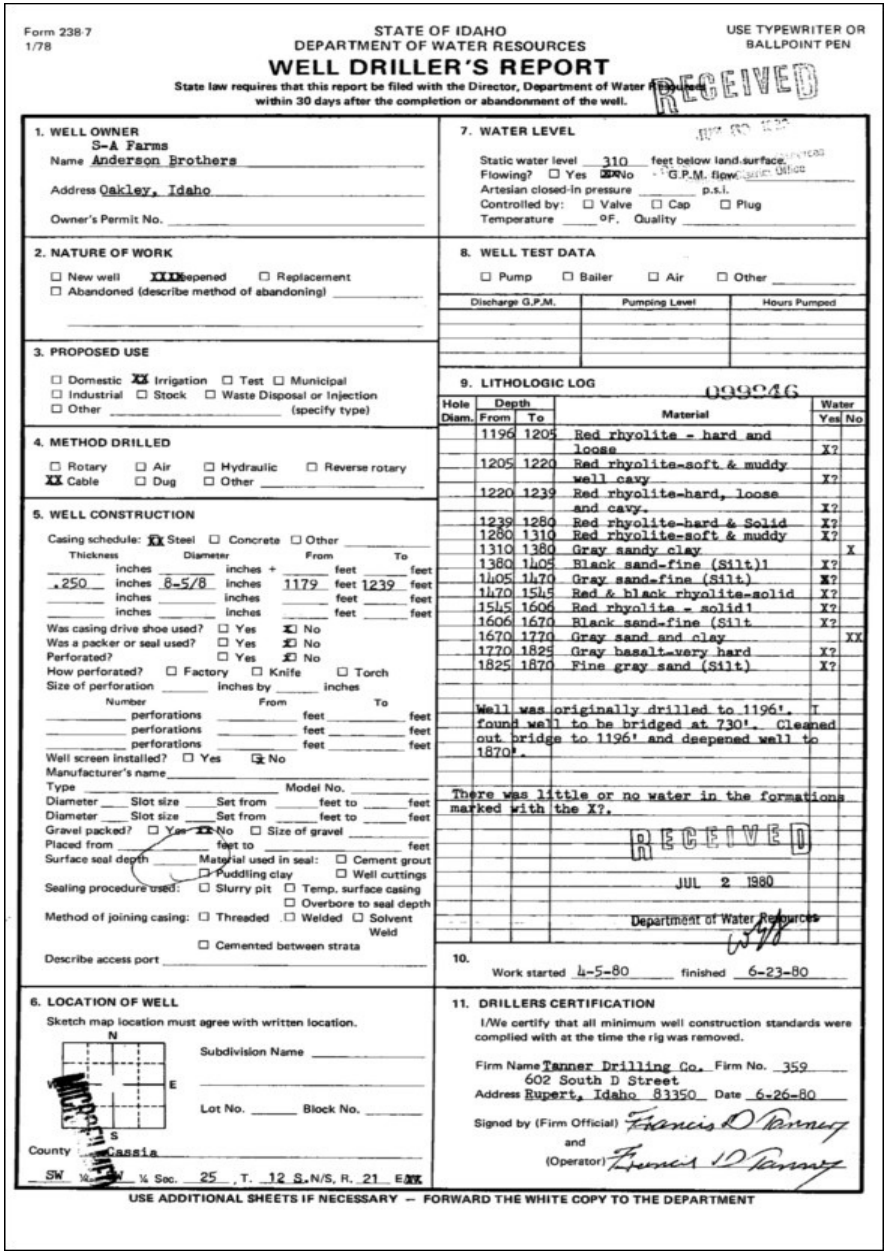
Well Driller Commons drilling

Well Location 12S21E25

WELL LOG

From Feet	To Feet	Type of Material	Water-bearing Formation Ans. Yes or No	Casing Perforated Ans. Yes or No
610	637	Black lava		
637	650	Soft, broken &rotten lava		
650	705	Black lava, solid		
705	810	Red rhylite, solid		
810	940	Brown rhylite,solid		
940	1021	Brown rhylite, mucky		
1021	1030	Brown rhylite, broken		
1030	1105	Brown rhylite with sandy clay mix		
1105	1150	Gray rhylite & sandy clay mix		
1150	1196	Brown rhylite with very mucky and sandy claymix		
		SWSW 5.25 125 ?16		

Well 12S21E-25CCC1 originally completed into rhyolite, cased to 1129’. No report of water from any depth in log.



Form 238-7
1/78

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

USE TYPEWRITER OR BALLPOINT PEN

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

RECEIVED

1. WELL OWNER
S-A Farms
Name Anderson Brothers
Address Oakley, Idaho
Owner's Permit No.

2. NATURE OF WORK
☐ New well ☒ Deepened ☐ Replacement
☐ Abandoned (describe method of abandoning)

3. PROPOSED USE
☐ Domestic ☒ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other (specify type)

4. METHOD DRILLED
☐ Rotary ☐ Air ☐ Hydraulic ☐ Reverse rotary
☒ Cable ☐ Dug ☐ Other

5. WELL CONSTRUCTION
Casing schedule: ☒ Steel ☐ Concrete ☐ Other

Thickness	Diameter	From	To
inches	inches +	feet	feet
.250 inches	8-5/8 inches	1179 feet	1239 feet
inches	inches	feet	feet
inches	inches	feet	feet

Was casing drive shoe used? ☐ Yes ☒ No
Was a packer or seal used? ☐ Yes ☒ No
Perforated? ☐ Yes ☒ No
How perforated? ☐ Factory ☐ Knife ☐ Torch
Size of perforation inches by inches

Number	From	To
perforations	feet	feet
perforations	feet	feet
perforations	feet	feet

Well screen installed? ☐ Yes ☒ No
Manufacturer's name
Type Model No.
Diameter Slot size Set from feet to feet
Diameter Slot size Set from feet to feet
Gravel packed? ☐ Yes ☒ No ☐ Size of gravel
Placed from feet to feet
Surface seal depth Material used in seal: ☐ Cement grout ☐ Puddling clay ☐ Well cuttings
Sealing procedure used: ☐ Slurry pit ☐ Temp. surface casing ☐ Overbore to seal depth
Method of joining casing: ☐ Threaded ☐ Welded ☐ Solvent Weld ☐ Cemented between strata
Describe access port

6. LOCATION OF WELL
Sketch map location must agree with written location.

Subdivision Name
Lot No. Block No.
County Cassia
SW ¼ NW ¼ Sec. 25, T. 12 S. N/S, R. 21 E W

7. WATER LEVEL
Static water level 310 feet below land surface.
Flowing? ☐ Yes ☒ No G.P.M. flow
Artesian closed-in pressure p.s.i.
Controlled by: ☐ Valve ☐ Cap ☐ Plug
Temperature °F. Quality

8. WELL TEST DATA
☐ Pump ☐ Bailer ☐ Air ☐ Other

Discharge G.P.M.	Pumping Level	Hours Pumped

9. LITHOLOGIC LOG
099946

Hole Diam.	Depth From	Depth To	Material	Water Yes	Water No
	1196	1205	Red rhyolite - hard and loose	X?	
	1205	1220	Red rhyolite-soft & muddy well cavy	X?	
	1220	1239	Red rhyolite-hard, loose and cavy.	X?	
	1239	1280	Red rhyolite-hard & Solid	X?	
	1280	1310	Red rhyolite-soft & muddy	X?	
	1310	1380	Gray sandy clay		X
	1380	1405	Black sand-fine (Silt)1	X?	
	1405	1470	Gray sand-fine (Silt)	X?	
	1470	1545	Red & black rhyolite-solid	X?	
	1545	1606	Red rhyolite - solid1	X?	
	1606	1670	Black sand-fine (Silt	X?	
	1670	1770	Gray sand and clay		XX
	1770	1825	Gray basalt-very hard	X?	
	1825	1870	Fine gray sand (Silt)	X?	

Well was originally drilled to 1196'. I found well to be bridged at 730'. Cleaned out bridge to 1196' and deepened well to 1870'.

There was little or no water in the formations marked with the X?.

RECEIVED
JUL 2 1980
Department of Water Resources

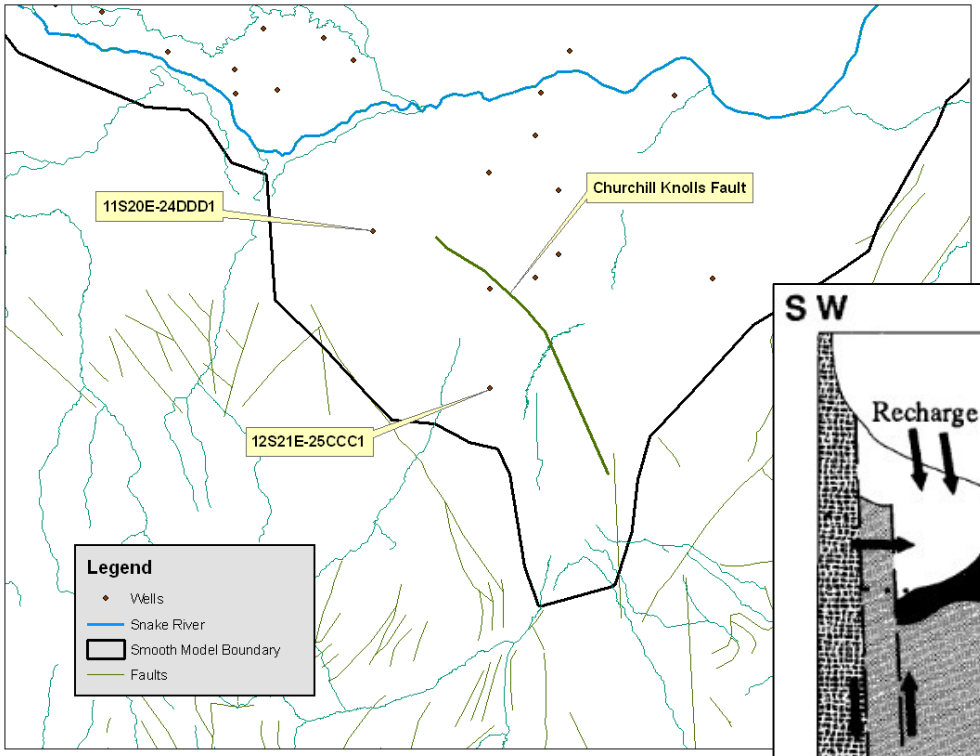
10.
Work started 4-5-80 finished 6-23-80

11. DRILLERS CERTIFICATION
I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name Tanner Drilling Co. Firm No. 359
602 South D Street
Address Rupert, Idaho 83350 Date 6-26-80
Signed by (Firm Official) Francis D Tanner
and
(Operator) Francis D Tanner

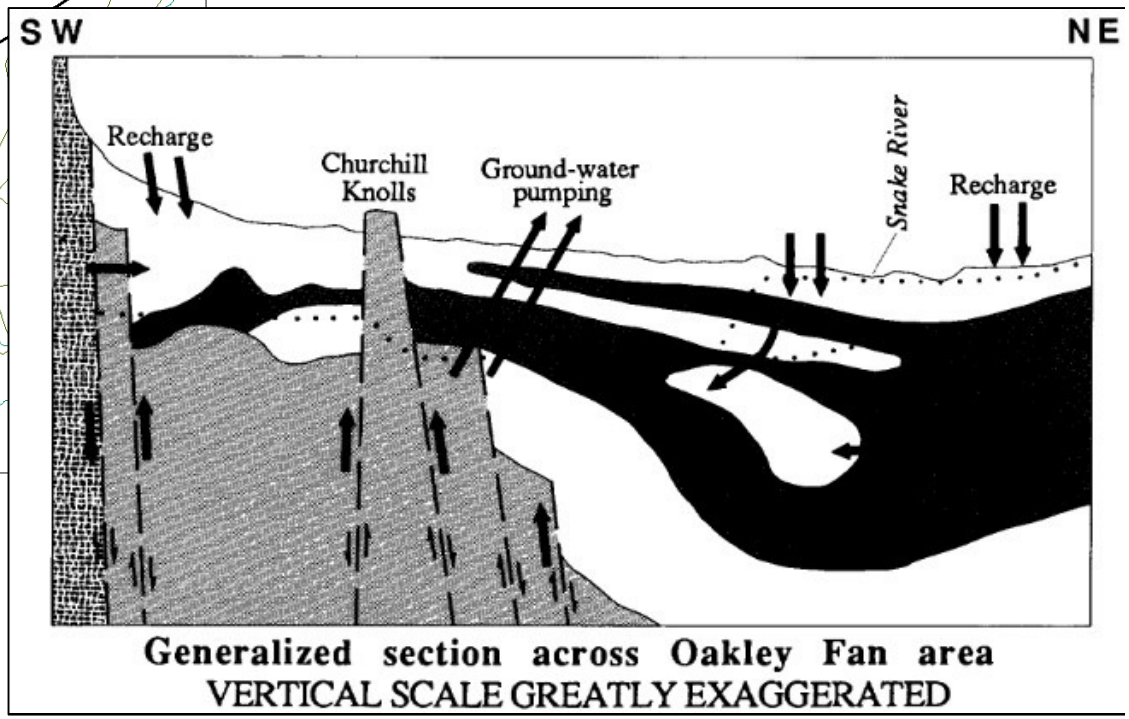
USE ADDITIONAL SHEETS IF NECESSARY -- FORWARD THE WHITE COPY TO THE DEPARTMENT

Well 12S21E-25CCC1 deepened to 1870' in 1980. Casing was extended to 1239', into rhyolite. Only trace amounts of water reported in log.



Churchill fault location adapted from Young and Newton, 1989

Adapted from Young and Newton, 1989



Wells 12S21E-25CCC1 and 11S20E-24DDD1 appear to be deriving water from both basalt and rhyolite. Both lithologies are not very productive, and the wells have been drilled beyond 1000' in search of usable volumes of water. It is unclear if these wells are outside of the regional aquifer, or in an unproductive region which is close to the aquifer's edge. Other wells in the area experienced greater than 20' of drawdown and appear to be completed in the regional aquifer (1980 – 2001).

New Business: Changes in Aquifer Storage Volume

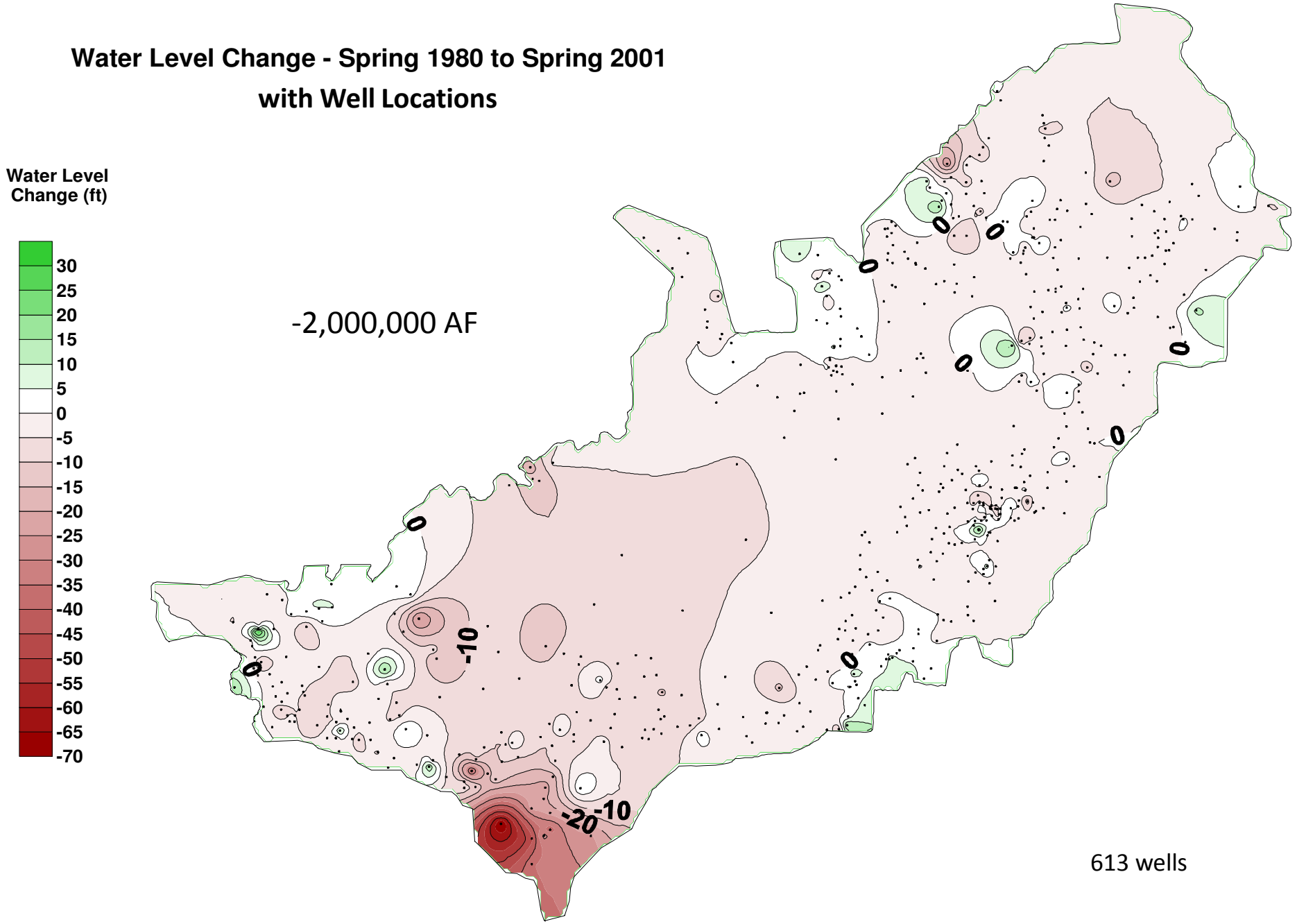
The change in aquifer storage has been estimated using the synoptic water-level data. The volume of change in storage was calculated as follows:

1. Change point data was interpolated with Geostatistical Analyst in ArcMap®.
2. Water-level change values from the raster (change-map) were assigned to model cell centroids using interpolated pixel values.
3. The new water-level-change point values were joined to the calibrated Sy Model Grid from ESPAM1.1.
4. The cell area was multiplied with the water-level-change value and the Sy value to get change volume by model cell.
5. Sum cell change volumes.

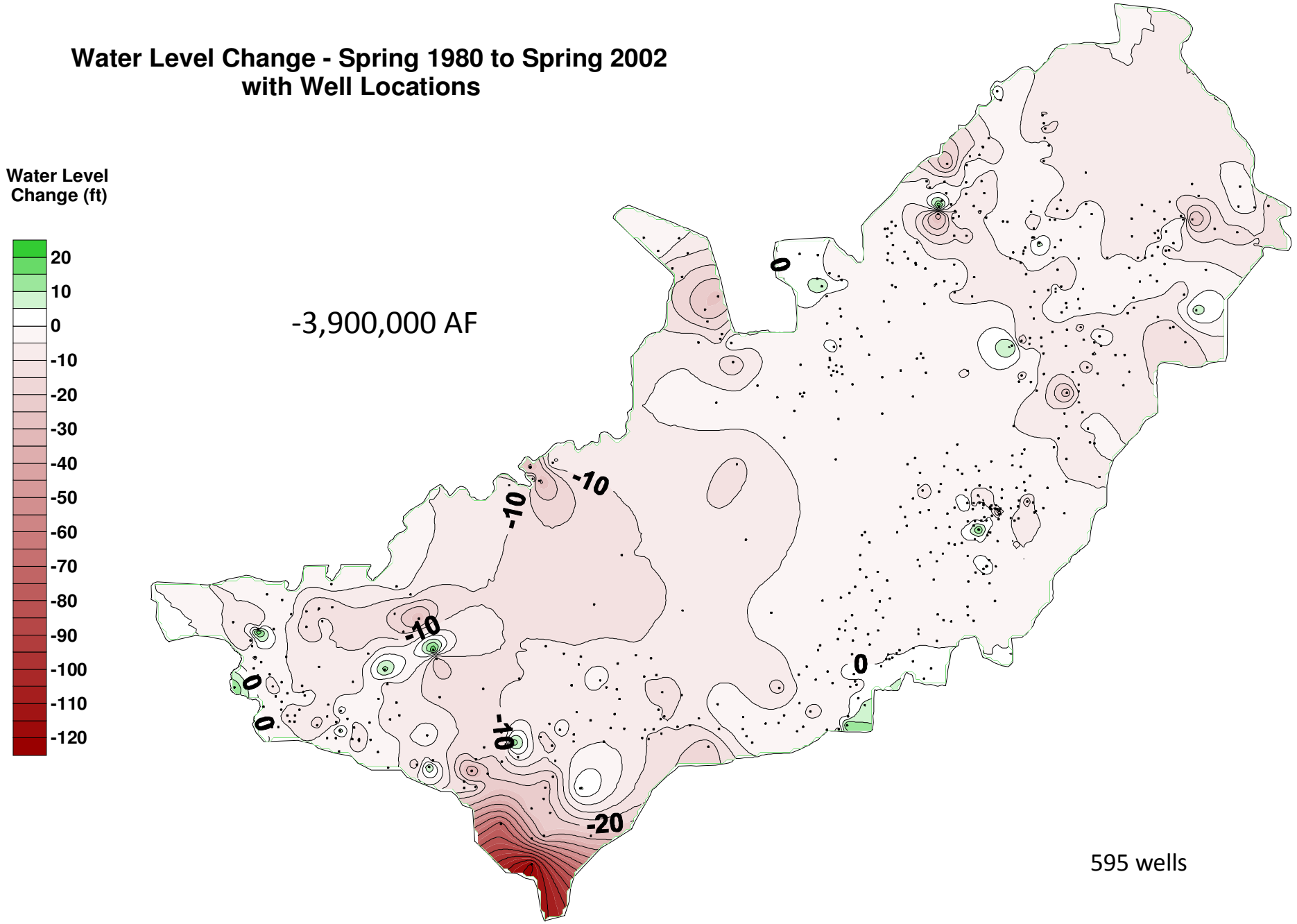
The process was repeated using the average Sy value of 0.070488 from ESPAM1.1.

Grid math volume calculation in Surfer® was used to check the GIS volume calculations. The average Sy value of 0.070488 from ESPAM1.1 was used in the Surfer® calculations.

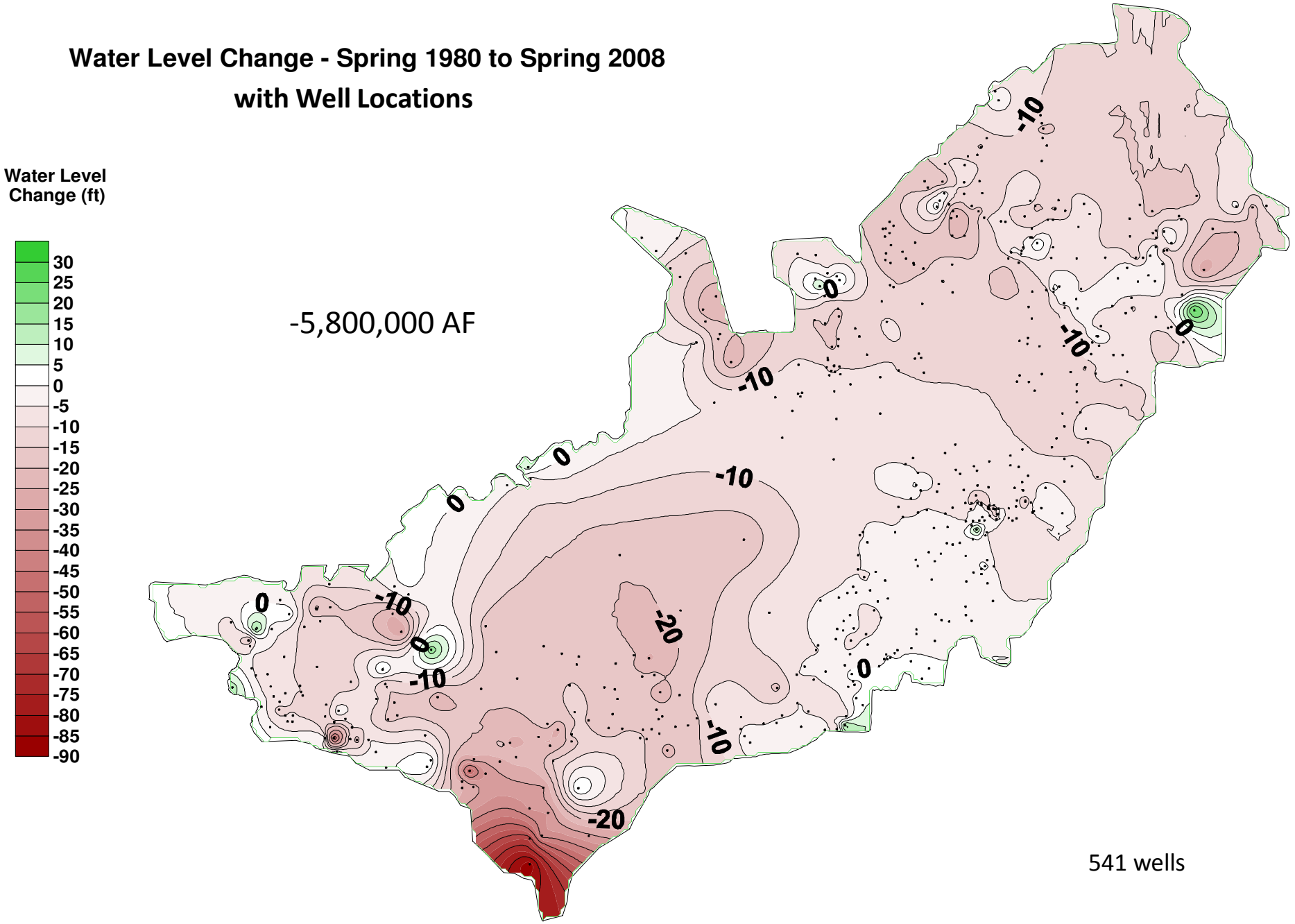
Water Level Change - Spring 1980 to Spring 2001 with Well Locations



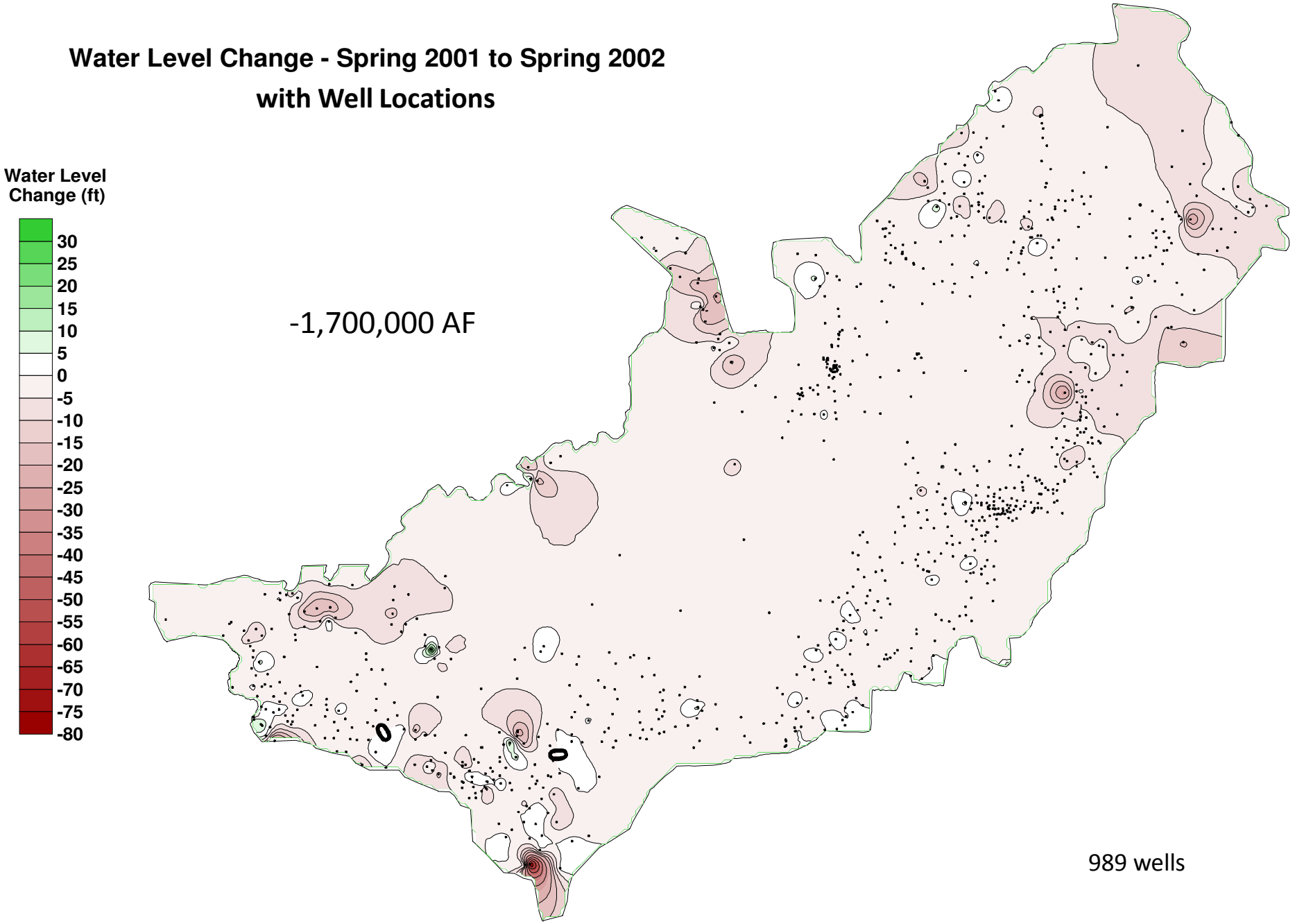
Water Level Change - Spring 1980 to Spring 2002 with Well Locations



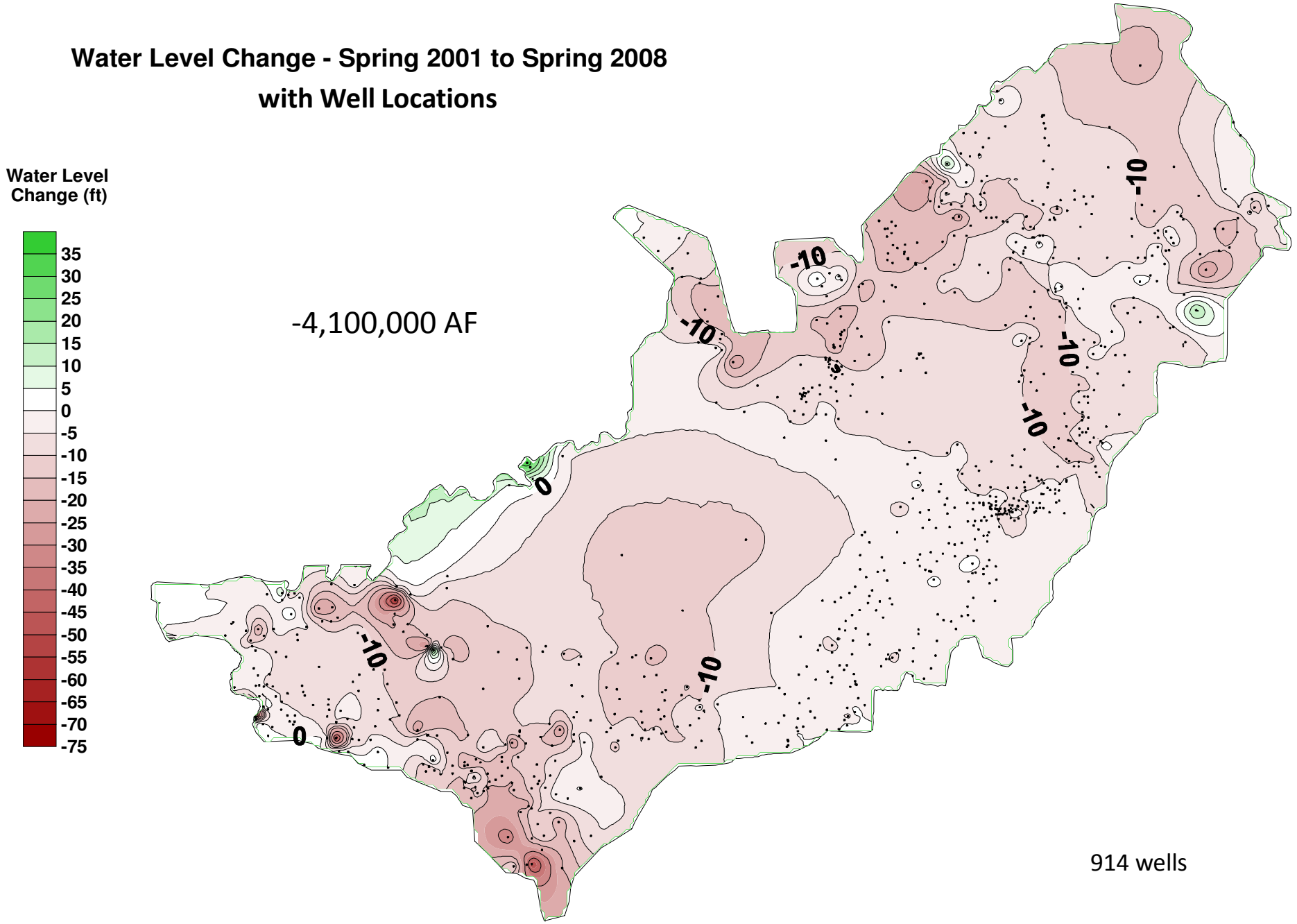
Water Level Change - Spring 1980 to Spring 2008 with Well Locations



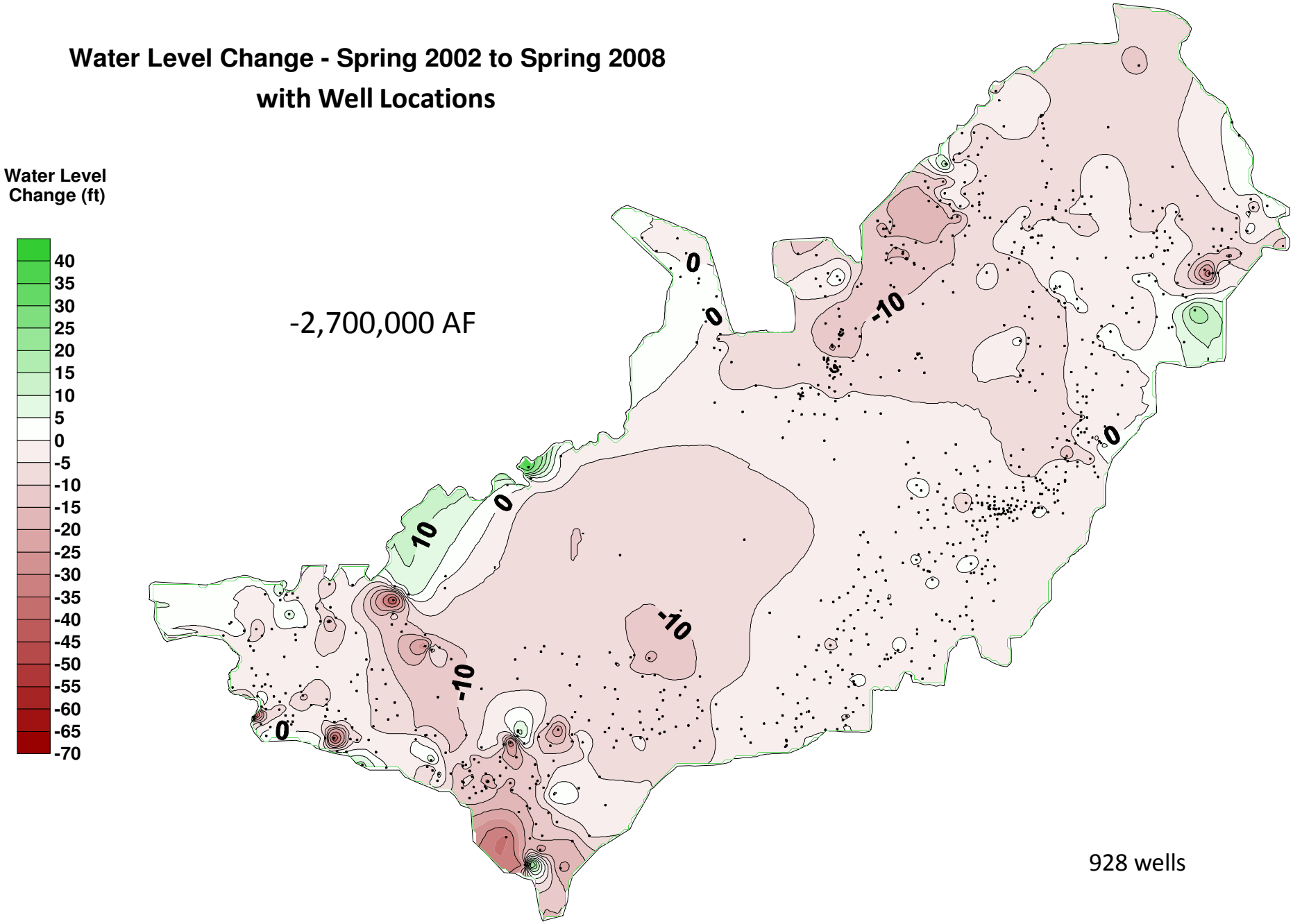
Water Level Change - Spring 2001 to Spring 2002 with Well Locations



Water Level Change - Spring 2001 to Spring 2008 with Well Locations



Water Level Change - Spring 2002 to Spring 2008 with Well Locations



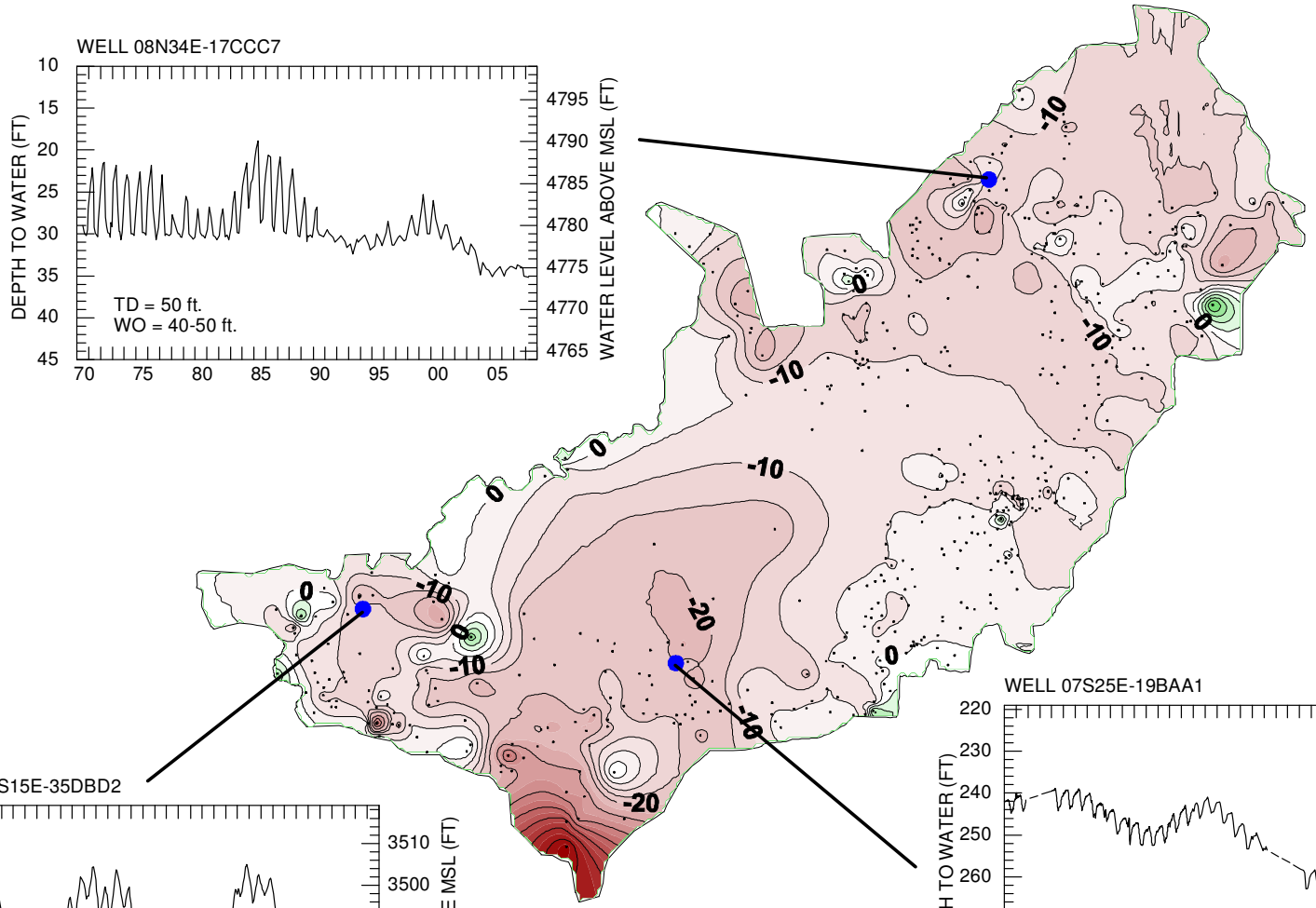
Calculated Storage Volumes

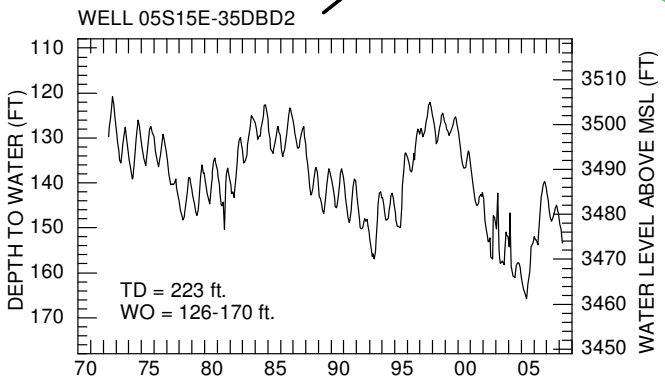
Volume of water from change maps and ESPAM1.1 calibrated Sy distribution			
	Calibrated Sy Distribution (ESPAM 1.1)	Average Sy 0.070488 (ESPAM1.1)	Check with Surfer® (Sy 0.070488)
Change Years	Volume (AF)	Volume (AF)	Volume (AF)
SP2001-SP2002	-1,728,867	-1,668,280	-1,684,091
SP2002-SP2008	-2,857,427	-2,648,868	-2,664,143
SP2001-SP2008	-4,407,390	-4,071,544	-4,098,400
SP1980-SP2001	-1,968,402	-1,978,546	-1,995,342
SP1980-SP2002	-4,048,123	-3,845,664	-3,873,018
SP1980 - SP2008	-6,183,513	-5,736,486	-5,786,209

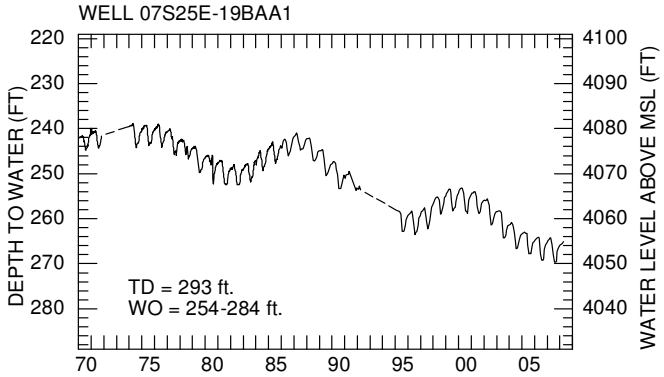
Note: Previous slides report the SURFER® calculated storage volume.

Are these change maps snapshots that capture the trend in regional water-level changes over time, or do they represent discrete phenomena (measurement error, pumping, etc.)?

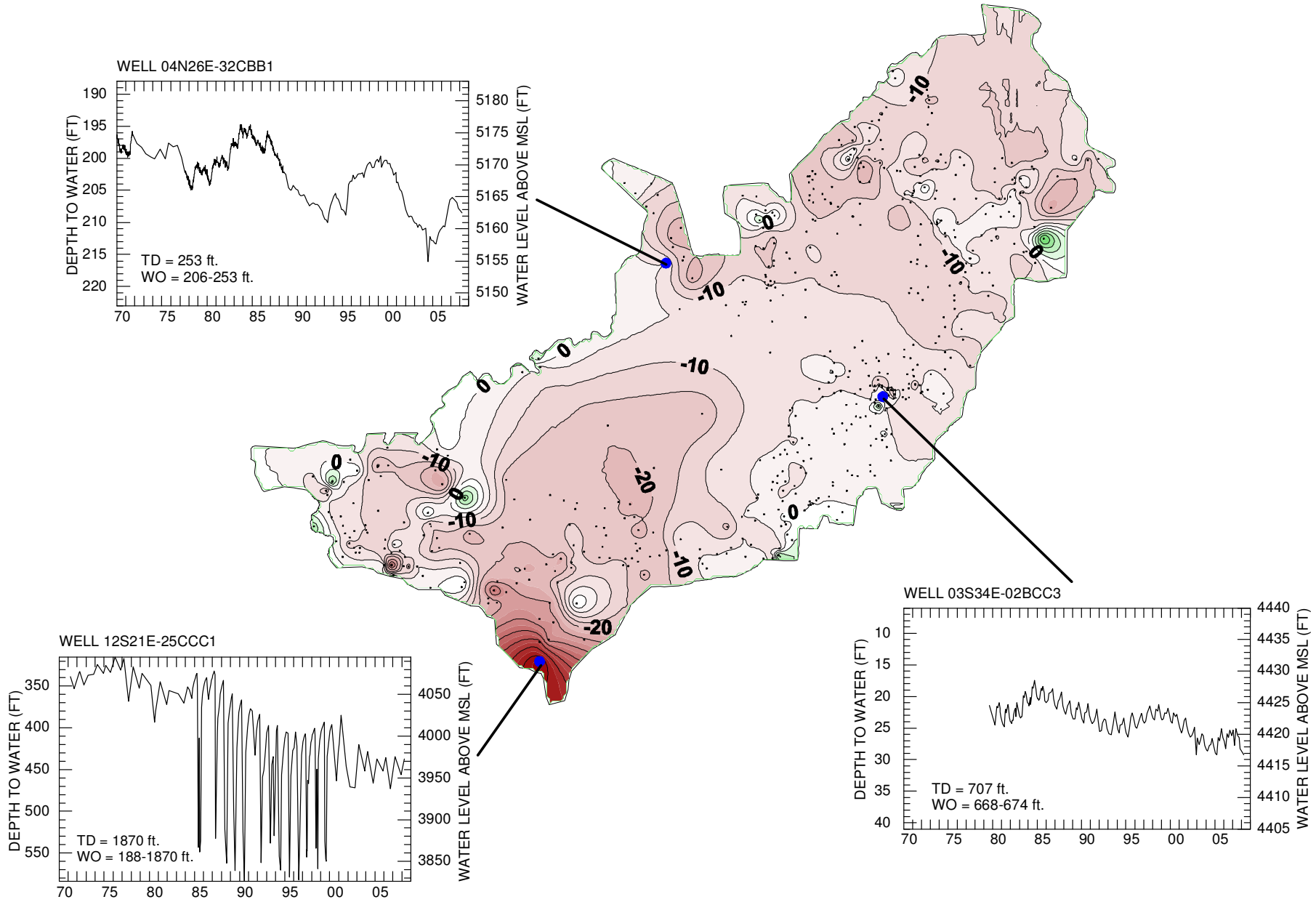
Water Level Change - Spring 1980 to Spring 2008 with Select Well Hydrographs



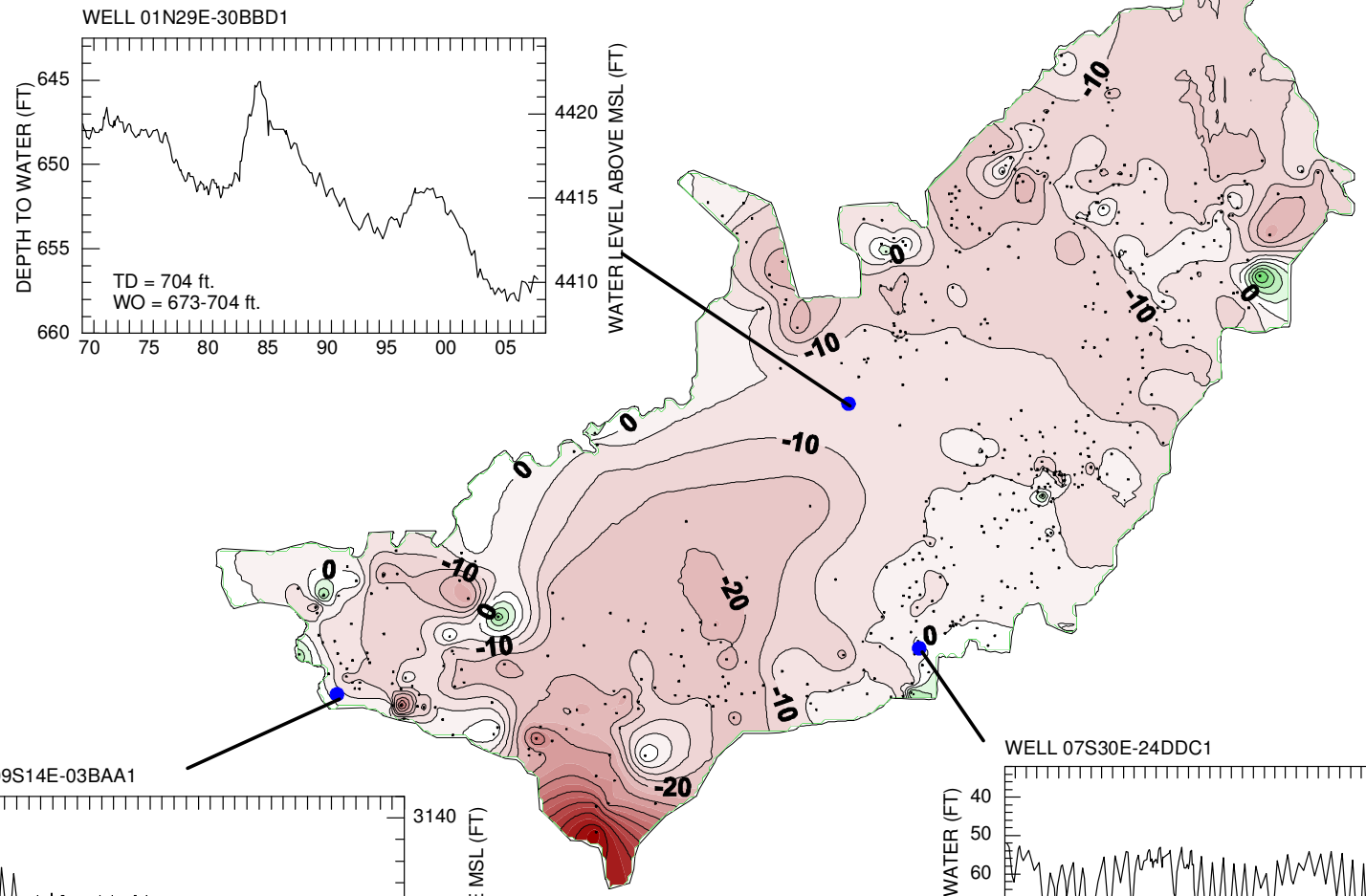


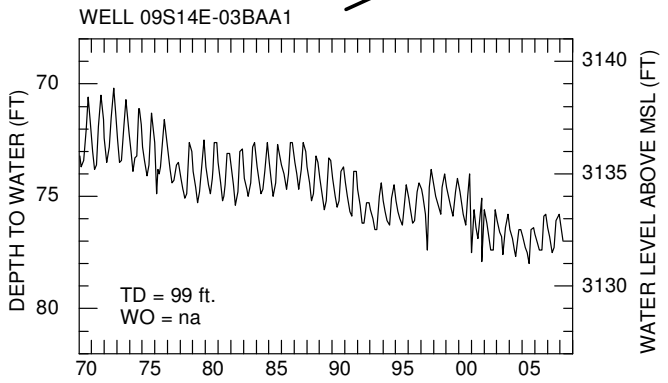


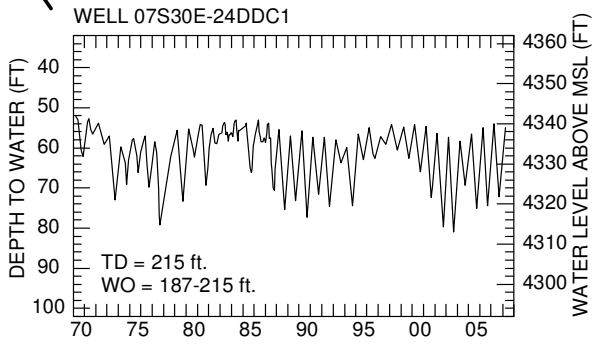
Water Level Change - Spring 1980 to Spring 2008
with Select Well Hydrographs

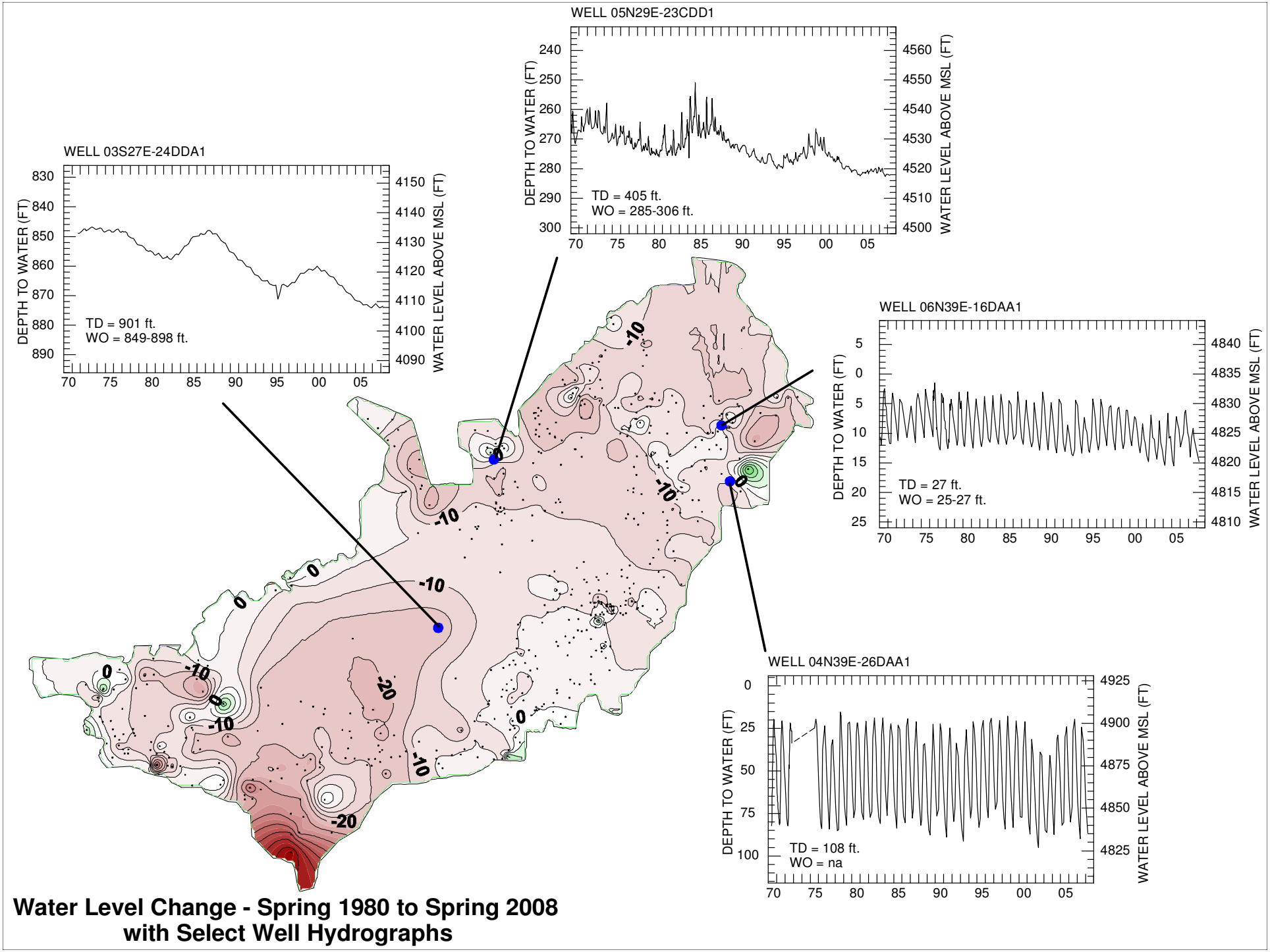


Water Level Change - Spring 1980 to Spring 2008 with Select Well Hydrographs





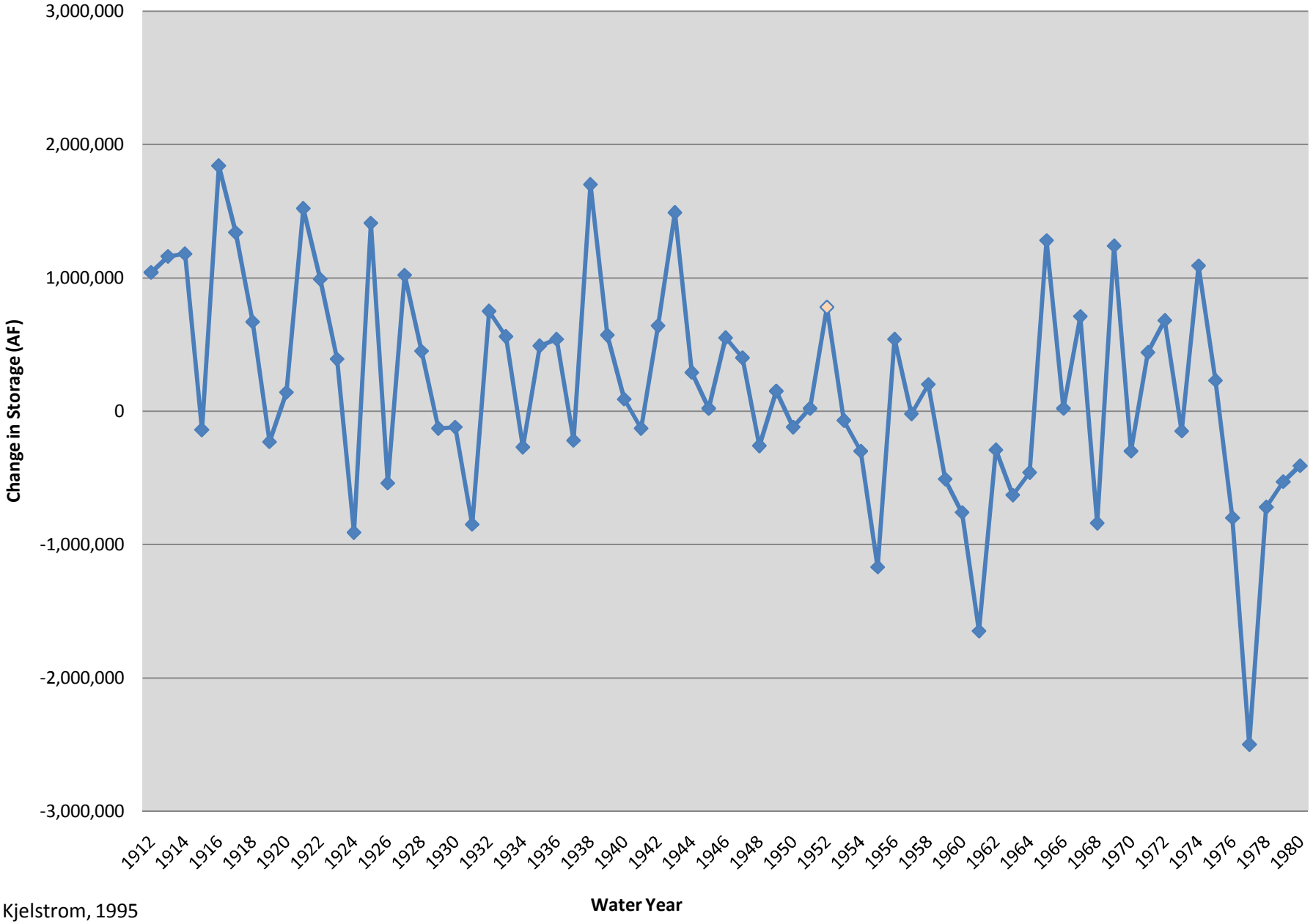




Water Level Change - Spring 1980 to Spring 2008
with Select Well Hydrographs

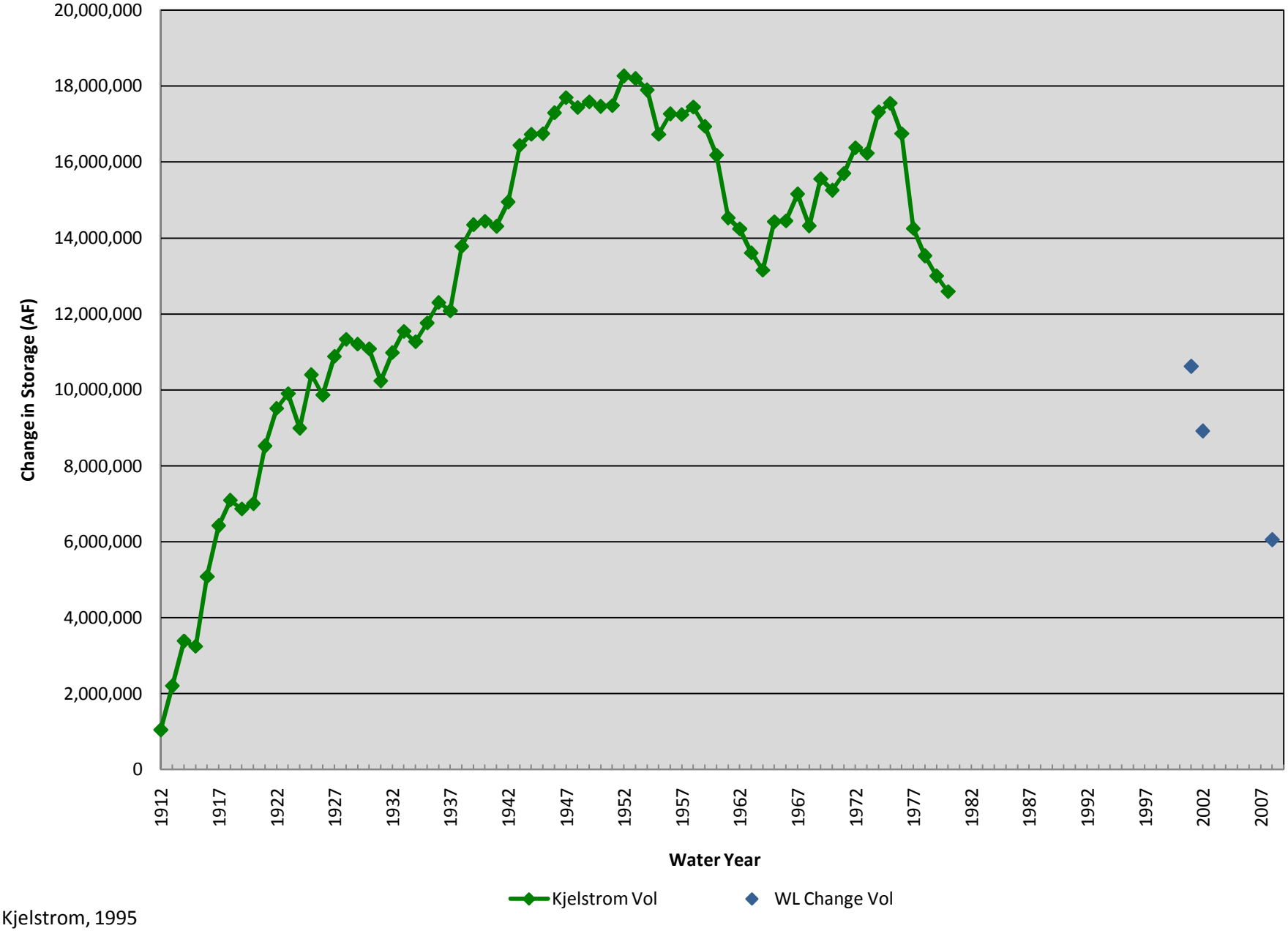
Approximately 2,000,000 AF of water was removed from storage between 2001 and 2002, and approximately 6,000,000 AF between 1980 and 2008. Are these change-in-storage values reasonable?

Historic Annual Change in Storage



Kjelstrom, 1995

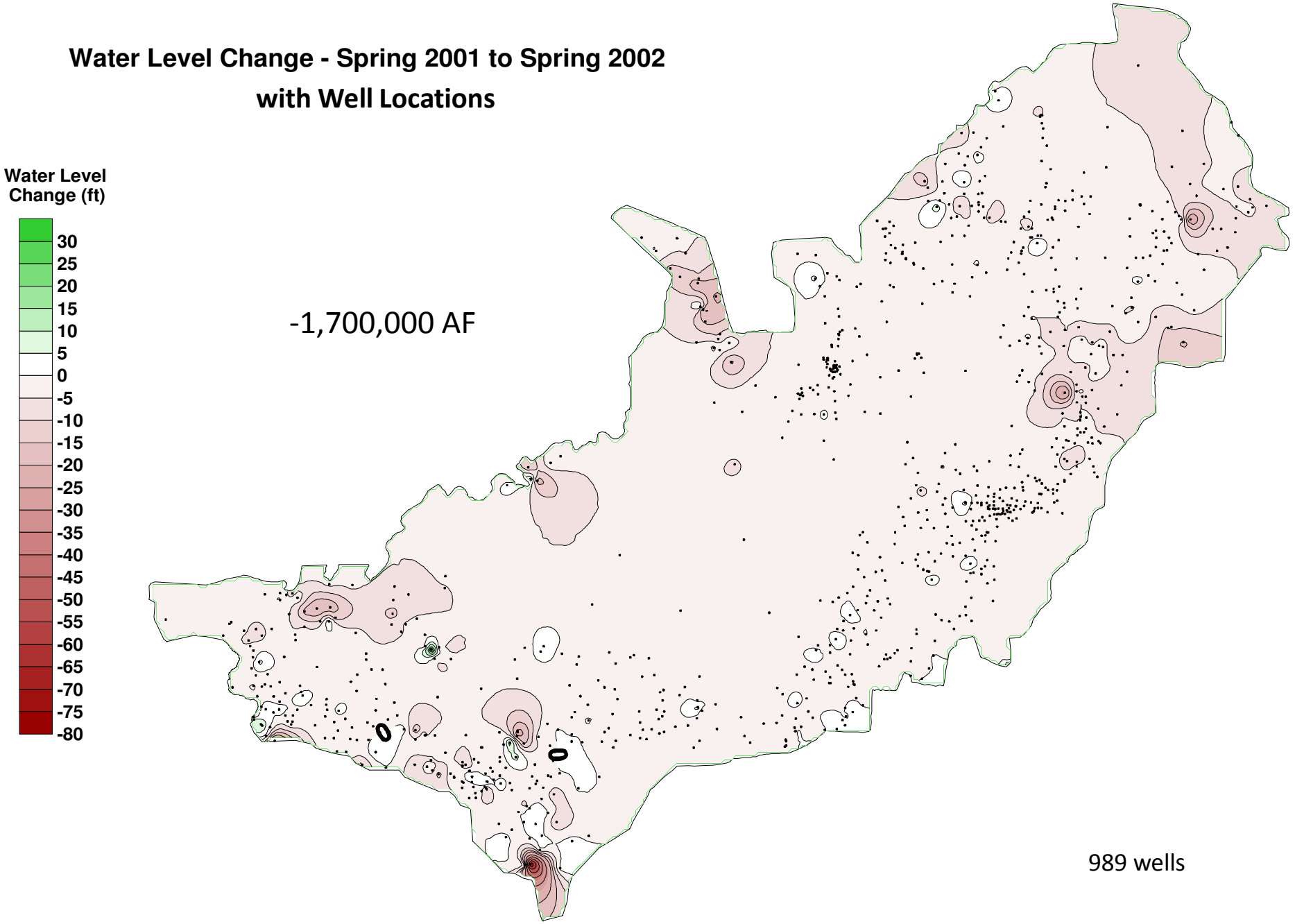
Historic Cumulative Change in Storage

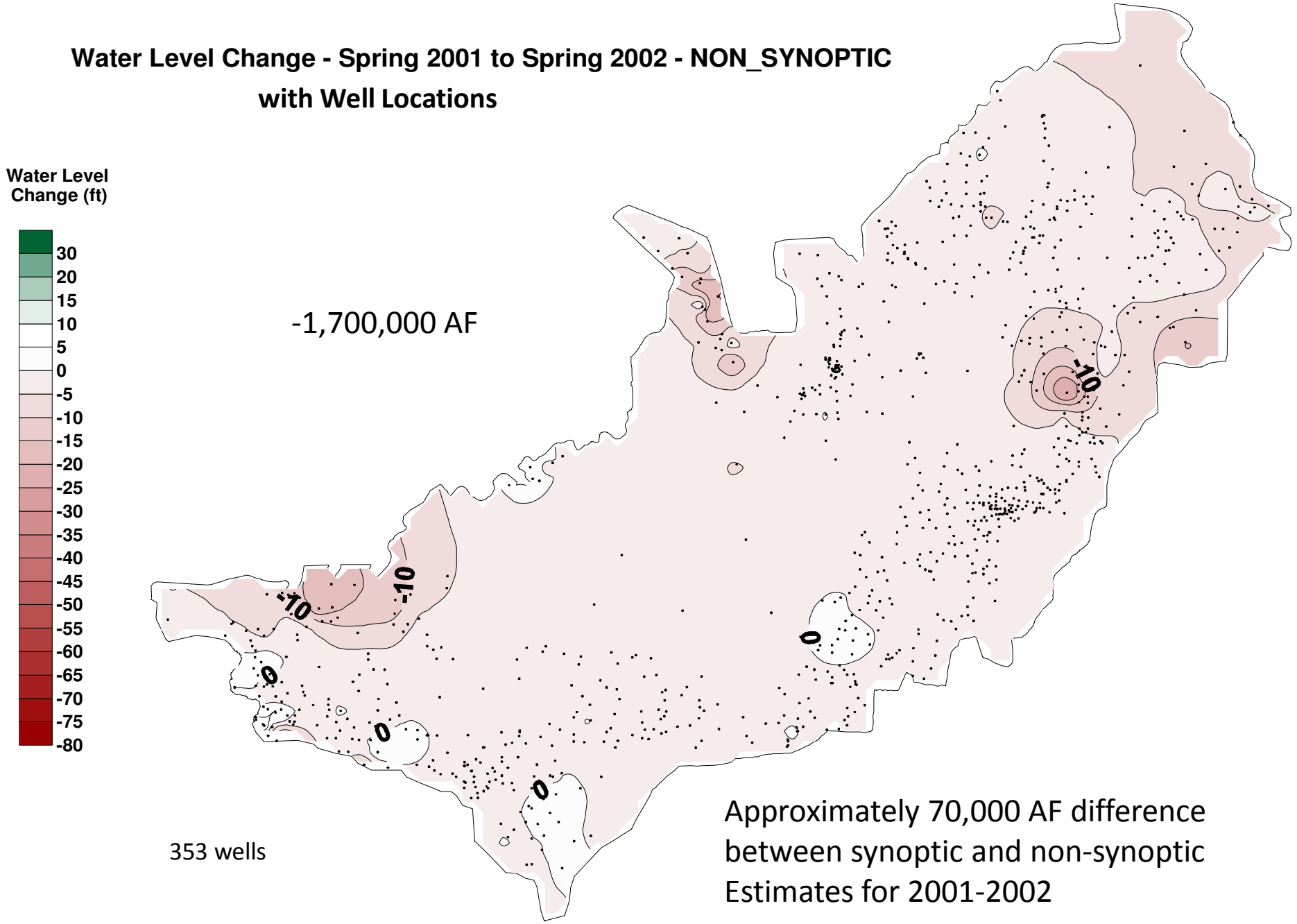


Kjelstrom, 1995

The comparison with Kjelstrom indicates that the change-in-storage volumes are within the range of historical changes, and the cumulative change seems to make sense. However, there is a large data gap between the Kjelstrom estimates and the synoptic estimates. Let's try to estimate storage changes with typical spring-time measurements (non-synoptic).

Water Level Change - Spring 2001 to Spring 2002 with Well Locations

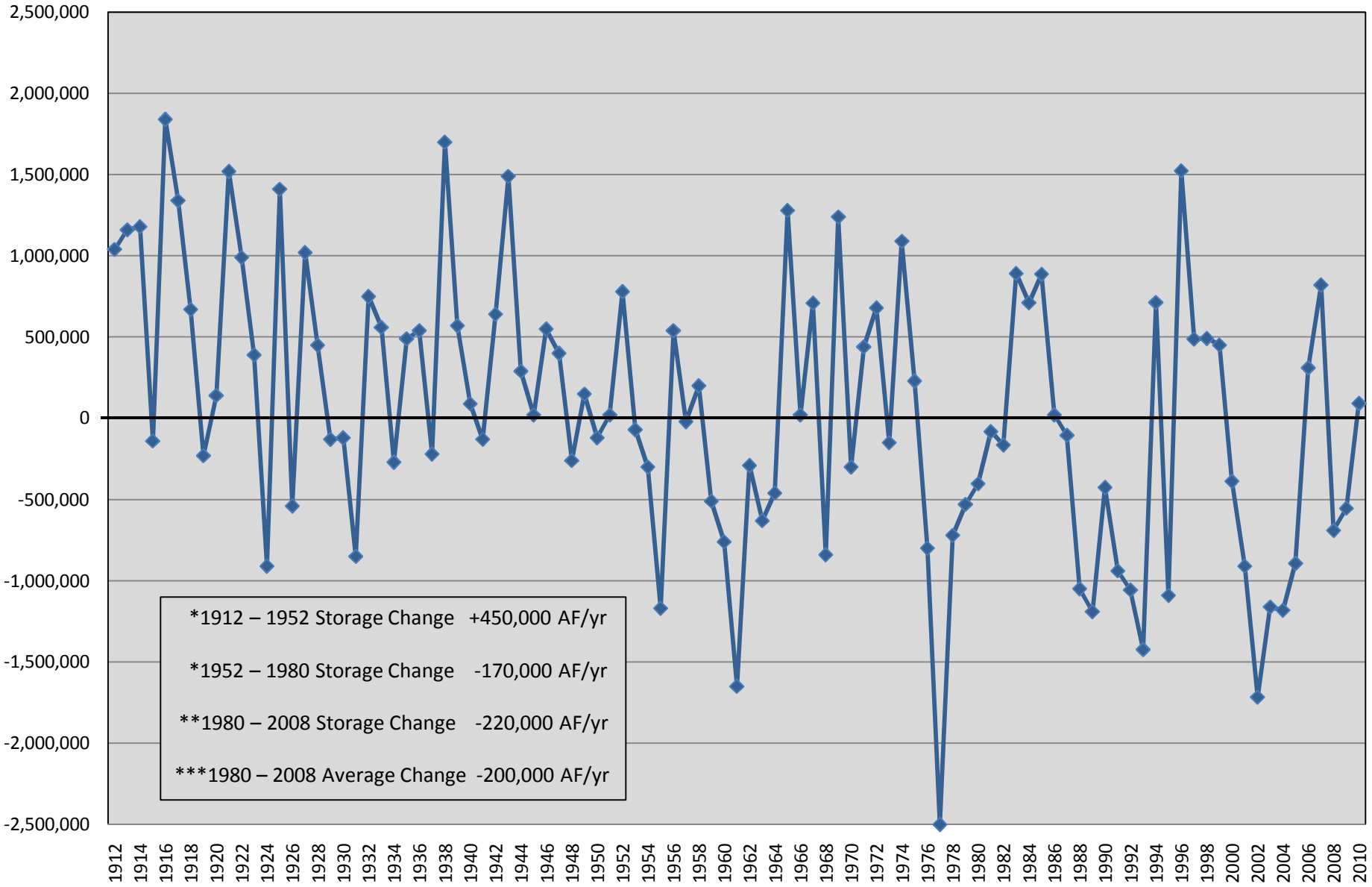



Water Level Change - Spring 2001 to Spring 2002 - NON_SYNOPTIC
with Well Locations
Water Level Change (ft)
30
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-1,700,000 AF
-10
-10
-10
0
0
0
0
353 wells
Approximately 70,000 AF difference between synoptic and non-synoptic Estimates for 2001-2002

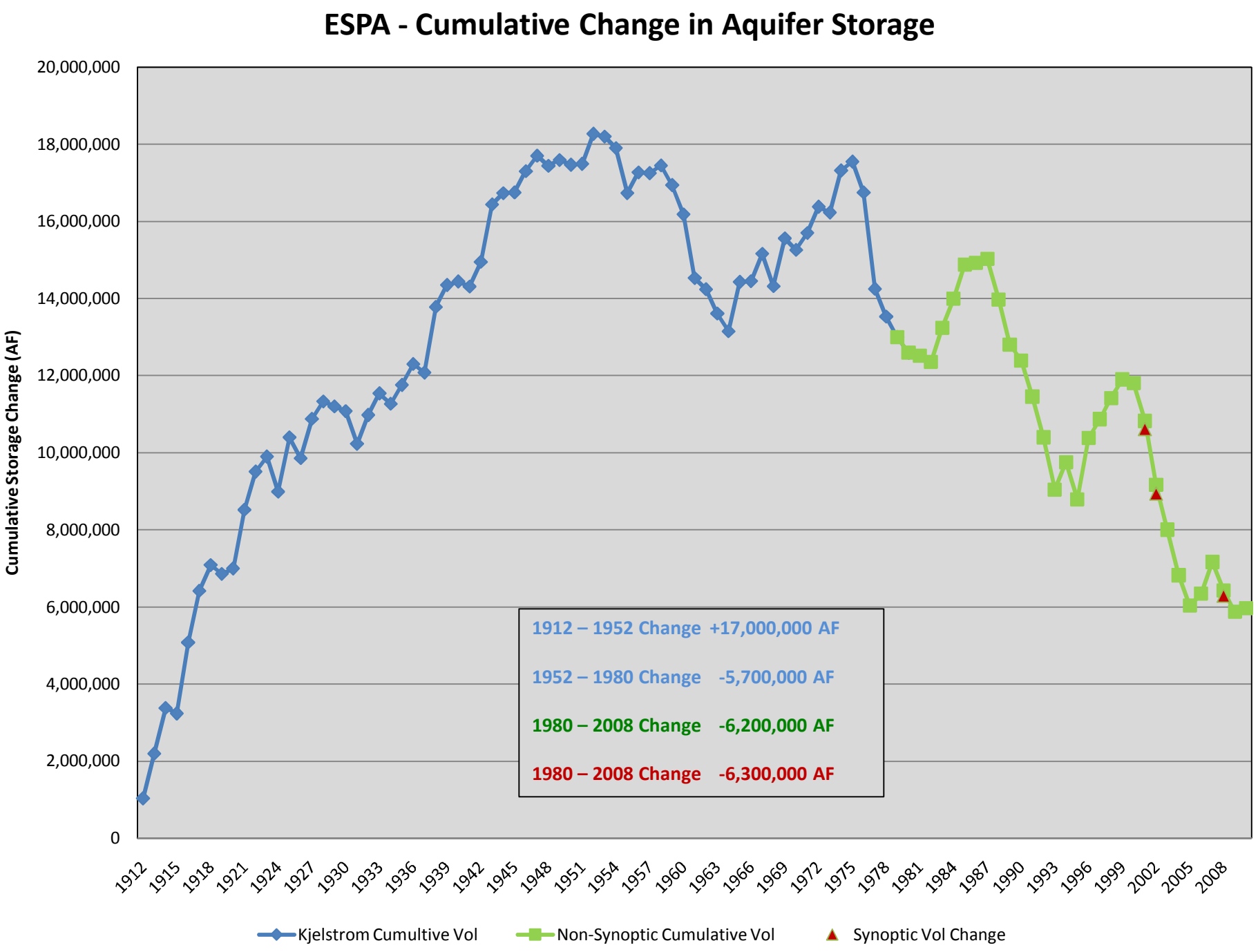
Comparison of Calculated Storage Volumes

Comparison of Synoptic and Non-synoptic volume calculations				
	Synoptic Average Sy 0.070488 (ESPAM1.1)	Non-Synoptic Average Sy 0.070488 (ESPAM1.1)	Difference (AF)	Difference (%)
Change Years	Volume (AF)	Volume (AF)	Volume (AF)	
SP2001-SP2002	-1,668,280	-1,659,658	-8,622	1%
SP2002-SP2008	-2,648,868	-2,738,924	90,056	-3%
SP2001-SP2008	-4,071,544	-4,398,582	327,038	-8%
SP1980-SP2001	-1,978,546	-1,772,623	-205,923	10%
SP1980-SP2002	-3,845,664	-3,432,280	-413,383	11%
SP1980 - SP2008	-5,736,486	-6,171,205	434,718	-8%

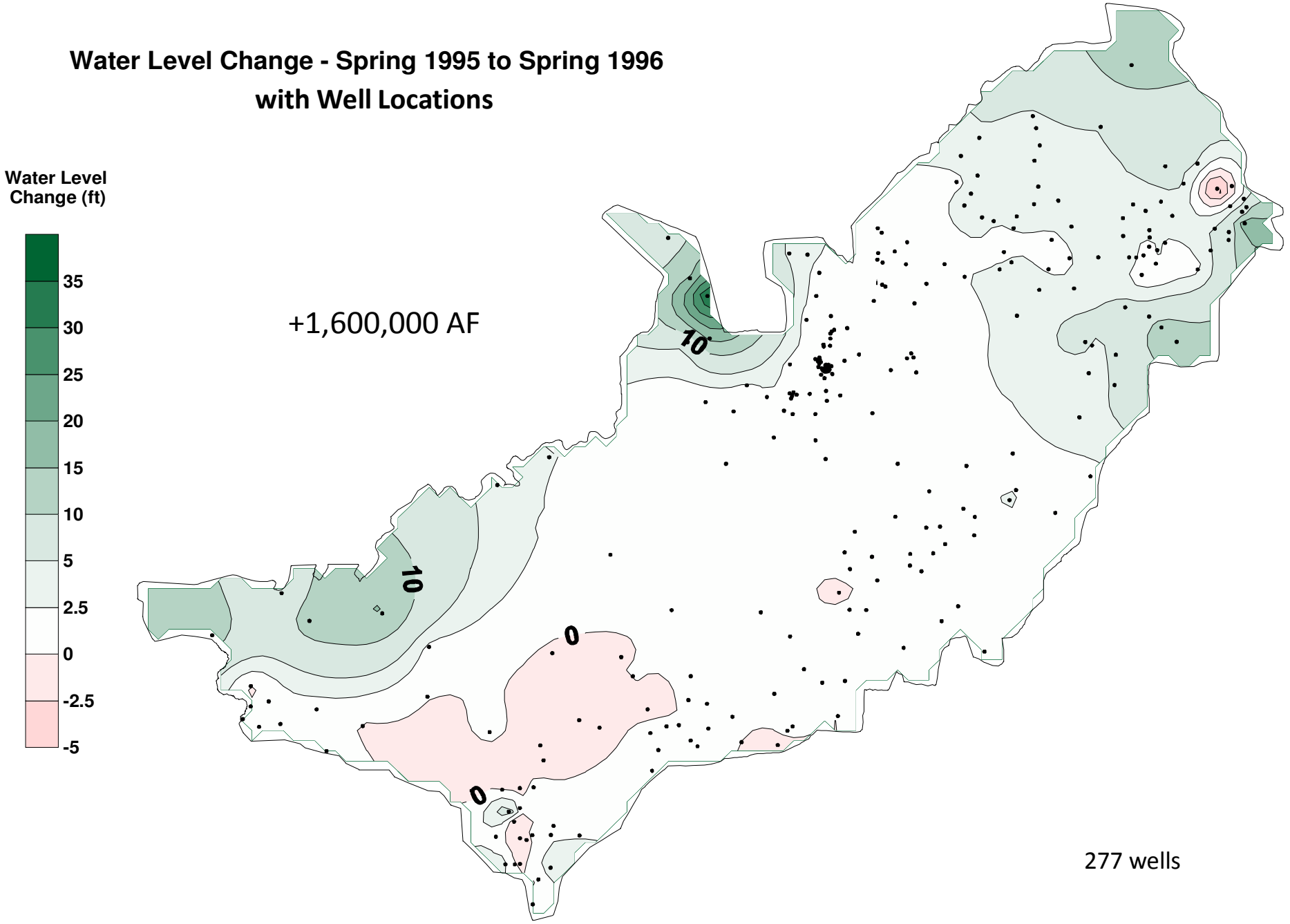
Annual Storage Change



*1912 – 1980 Storage changes, and 1952 – 1980 Storage changes from Kjelstrom, 1995. **1980 – 2008 Storage changes based on non-synoptic spring water level measurements. ***1980 – 2008 Average Change based on Synoptic Measurement difference.


ESPA - Cumulative Change in Aquifer Storage
Cumulative Storage Change (AF)
20,000,000
18,000,000
16,000,000
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
1912
1915
1918
1921
1924
1927
1930
1933
1936
1939
1942
1945
1948
1951
1954
1957
1960
1963
1966
1969
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
2008
1912 – 1952 Change +17,000,000 AF
1952 – 1980 Change -5,700,000 AF
1980 – 2008 Change -6,200,000 AF
1980 – 2008 Change -6,300,000 AF
Kjelstrom Cumultive Vol
Non-Synoptic Cumulative Vol
Synoptic Vol Change

Water Level Change - Spring 1995 to Spring 1996 with Well Locations



Discussion.